"Outlines in Anatomy, Physiology, and Hygiene."

ARMENTROUT.

OUTLINES

IN

ANATOMY, PHYSIOLOGY,

AND

HYGIENE.

BY J. C. ARMENTROUT,

INSTRUCTOR IN ANATOMY, PHYSIOLOGY, AND HYGIENE, IN THE IOWA CITY ACADEMY.

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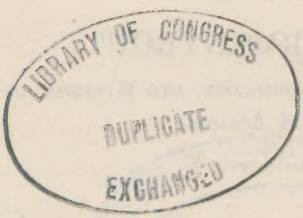

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PREFACE.

My only excuse for the publication of this little work, is the earnest request of many of my pupils, to whom I have presented, in the class-room, this system of instruction, and the desire to render my own work lighter, yet more effective, in the future. The work has been prepared under many inconveniences, and with many interruptions. For this we ask the allowance of the critic.

With a few slight modifications, these OUTLINES are printed just as pupils copied them from the blackboard. They are not *Topic Lists* prepared to accompany any particular text-books, but are a simple classification and systematic arrangement of the subjects of which text-books of the kind treat; hence they are equally applicable to any text-book, thus causing a variety of books to be an advantage, rather than an obstacle,—a fact to which all who have taught by this method will testify. Enough subject matter has been given, however, so that a clear and practical knowledge of these important sciences may be obtained.

I am indebted to Dr. J. R. TOWNSEND, a practicing dentist of Iowa City, for the short dissertation on the *Teeth;* also to Dr. G. O. MORGRIDGE, of Muscatine, for valuable assistance in preparing the outline on the *Eye.*

The objects of instruction in the school-room are — to lead pupils to acquire habits of self-reliance in study, and the

ability to use text-books as means of self-culture; also to arouse a spirit of investigation, to develop in the pupil a power to separate things important from things unimportant, and to arrange the result of all work in systematic and logical order. If the presentation of this little work will assist my fellow teachers in reaching these ends, and create a greater thirst for knowledge and a higher idea of the work in which we are employed, then I will have realized my purpose.

J. C. Armentrout.

Iowa City, Iowa.

SUGGESTIONS TO TEACHERS.

1. Assign short lessons.

2. Preface the lesson of the preceding day with a few remarks upon each part of the outline assigned, and cite the parts of the text-book in which the required information can be found.

3. Require a pupil to write upon the board, from memory, the portion of the outline discussed, and allow the class to criticize his work.

4. Assign a member of the class an important question, the answer of which he is to determine and report at next recitation. Let the question be one that you desire to impress upon the minds of the class. The teacher may supplement the answer given by whatever is needed to a correct and a complete understanding of it.

5. Assign different pupils different parts of the outline from which to report. These reports may be given as review lessons, and the class should be allowed to criticize the work done.

6. Each day review the preceding lesson.

ERRATUM.

Page 30, fourth paragraph, second line, read "right," instead of "left," side.

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OUTLINES
IN
Anatomy, Physiology, and Hygiene.

CHAPTER I.

PHYSIOLOGY.

- PHYSIOLOGY
  - Definition.
  - Natural Divisions
    - Animal
      - Human.
      - Comparative.
    - Vegetable.

Definition.— PHYSIOLOGY is the study of the *work*, *motions*, *operations*, or *acts* of the different parts of organized bodies, either animal or vegetable.

An *organic body* is one made up or composed of organs, or it is one which has been produced by life. An *inorganic body* is one not composed of organs, or one which has not been produced by life.

All the parts of an *organized body* are mutually dependent, while each part of a mineral exists for itself.

Physiology is naturally divided into two parts, viz., *Animal* and *Vegetable*. Vegetables are nourished by absorbing and assimilating food by the external surface; the surface is greatly increased by leaves and roots. Both animals and vegetables require oxygen for their support — the former, however, exhale carbonic acid and retain some oxygen; the latter yielding the oxygen retain the carbon. Animals receive their nourishment through a mouth, into an internal digestive or alimentary canal.

The absorbents of animals are distributed along the walls of a digestive cavity, while of plants they are external.

Animal Physiology is divided into *Human* and *Comparative*. While *Human Physiology* treats of the *phenomena* presented by man, *Comparative Physiology* treats of those presented by the lower animals.

Human Physiology, because of its connection with *disease* and its *alleviation* and *cure*, is of more importance to us than comparative physiology, yet a good understanding of the *structure* and *work* of the various organs of the lower animals is essential to our physiological knowledge of the human body.

Many of the *vital phenomena* are common to all animals, and an acquaintance with these assists us in properly understanding the special physiology of the human body. Many *experiments* and *observations* can be made only upon the lower animals.

To *Human Physiology* belong certain vital phenomena *which take place in the human body*. First, those that are *mechanical* in their nature; as *the action of the elastic ligaments, the play of the articulating surfaces of bones upon each other*, and *the movements of the heart*. Those of a *chemical* nature take place in the interior of the body, as the formation of the *tissues* of the body from the elements of the food, fibrine, albumen, etc.

The *nervous phenomena* are such as belong to the *nervous system*, and are peculiar to it.

They bring the animal body into relation with the external world, and preserve it from external dangers, by means of sensation, movement, consciousness, and volition.— *Dalton.*

CHAPTER II.

BONES.

- BONES
  - Definition.
  - Structure.
  - Color.
  - Composition
    - Animal or Organic Matter.
    - Mineral or Inorganic Matter.
  - Marrow.
  - Coverings.
  - Divisions, according to form
    - Long.
    - Short.
    - Flat.
    - Irregular.
  - Blood-vessels.
  - Nerves.

The BONES are the organs of support of the animal frame. *Structure* — *hard*, *opaque*, and possessing a certain degree of *toughness* and *elasticity*.

In a section of bone, two kinds of tissue will be found,— one, *dense* and *compact* in texture; the other, like *lattice-work*, hence called *cancellous*.

In a *long bone*, the shaft is composed of the dense and compact tissue, while the extremities are composed mainly of the cancellated structure.

Color.—In a fresh state, *pinkish-white* externally, and a *deep red* internally.

Composition.— The animal or organic constituent forms about one-third; the mineral or inorganic, about two-thirds. The animal matter is composed of gelatine and blood-vessels; the principal part of the mineral matter is made up of *phosphate* and *carbonate of lime*.

There seems to be a difference in the amount of the two constituents of bone at different periods of life.

In childhood, the animal matter predominates; the bones are flexible, easily bent, and a fracture is not so common as

later in life. If a fracture does occur, however, the bones more readily knit together, and union quickly follows.

In old age, the *mineral matter* is in the ascendancy; the bones lose their toughness and elasticity, become more brittle, fractures readily occur, and are less liable to make a speedy and favorable union.

Coverings.— Periosteum, medullary membrane, or endosteum (sometimes called *internal periosteum*). The *periosteum* adheres closely to the surface of the bones, except at the articulating extremities, and where tendons or ligaments are attached directly to the bone.

The *medullary* or *cylindrical canal*, found in the bones of the limbs, is lined by the *endosteum*, a highly vascular areolar membrane.

Marrow.—A fatty, oleaginous substance, of a yellow color, in adult long bones; while, in young bones, it is a transparent reddish fluid.

Bones are divided, according to form, into *long*, *short*, *flat*, and *irregular*.

A *long bone* consists of a shaft and two articulating extremities. The shaft is a hollow cylinder, the walls of which consist of dense, compact tissue. The extremities are somewhat expanded, for the purpose of articulation and giving greater surface for muscular attachment. The long bones are *humerus*, *radius*, *ulna*, *femur*, *tibia*, *fibula*, *metacarpal* and *metatarsal*, *phalanges*, and *clavicle*.

Short bones are found where but slight and limited motion is required, and yet great strength is needed. They are the *carpus* and *tarsus*.

Flat bones are intended for the protection of certain parts, or to form broad surfaces for muscular attachment. These bones are composed of three layers, which, in the cranial bones, are known as the *tables of the skull*. These tables are known as the *outer*, thick and tough; the *inner*, thinner, denser, and more brittle; and the *middle*, cancellous (called also the *diploe*). The *occipital*, *parietal*, *frontal*, *ribs*, *nasal*, *lachrymal*, *vomer*, *scapulæ*, *sternum* and *ossa-innominata* are the flat bones.

The *irregular bones* are the *vertebræ*, *sacrum*, *coccyx*, *temporal*, *sphenoid*, *ethmoid*, *superior* and *inferior maxillary*, *palate*, *turbinated*, and *hyoid*.

Blood-vessels of bone are very numerous.

Nerves are distributed freely to the periosteum.

SKELETON.

- **Skeleton.**
  - Definition.
  - **Natural Divisions.**
    - **Head or Skull**
      - Cranium, 8 bones
        - Frontal.
        - Two Temporal.
        - Two Parietal.
        - Occipital.
        - Ethmoid.
        - Sphenoid.
      - Face, 14 bones
        - Two Malar or Cheek bones.
        - Two Lachrymal.
        - Two Palate.
        - Two Turbinated.
        - Two Nasal.
        - Two Superior Maxillary.
        - Inferior Maxillary.
        - Vomer.
    - **Trunk**
      - Thorax
        - Spinal Column, or Vertebræ
          - Seven Cervical.
          - Twelve Dorsal.
          - Five Lumbar.
        - Ribs
          - Seven True.
          - Three False.
          - Two Floating.
        - Sternum or Breast-bone.
        - Os-Hyoid.
      - Pelvis
        - Two Ossa-Innominata or nameless bones.
        - Sacrum.
        - Coccyx.
    - **Extremities.**
      - Upper
        - Shoulder
          - Clavicle.
          - Scapula.
        - Arm — Humerus.
        - Fore Arm
          - Radius.
          - Ulna.
        - Wrist — Carpus, eight in number.
        - Hand
          - Metacarpus.
          - Phalanges.
      - Lower
        - Femur, or thigh bone.
        - Tibia, or shin bone.
        - Patella, or knee pan.
        - Fibula, or small bone of the leg.
        - Tarsus, or instep bones — seven in number.
        - Metatarsus — five in number.
        - Phalanges — fourteen in number.

Skeleton ("dried up")—Is the bony frame work of an animal, designed for the support of the soft parts, and which sustains, by its physical solidity, the other organs. It also gives its general form or resemblance to the entire body.

Kinds of Skeletons.—*Natural Skeleton.*—One in which the bones are connected and held together by their own ligaments.

Artificial Skeleton.—One held together by wires or plates of silver, etc.

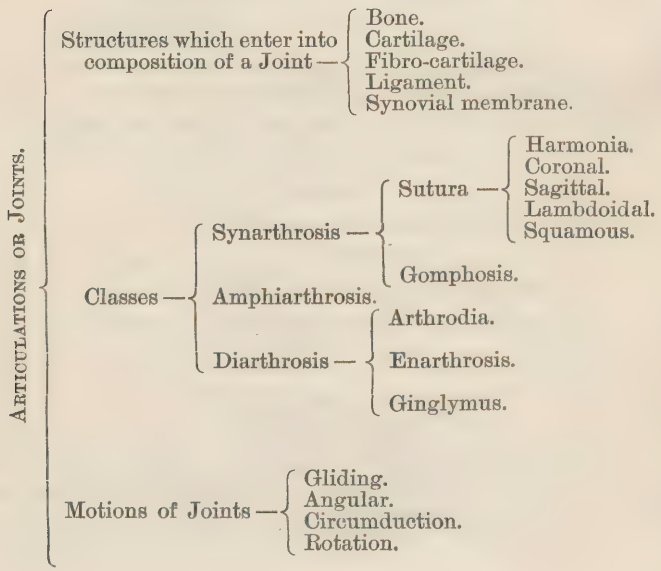
Endo or Neuro Skeleton.—One situated inside of the body, surrounding and protecting nervous matter. Found in vertebrate animals.

Exo or Dermo Skeleton (the skin).—The outward covering of many animals, such as the lobster, tortoise, crocodile, etc.

The *teacher* should give the *name, situation,* and a *brief description* of each bone of the Skeleton.

CHAPTER III.

ARTICULATIONS OR JOINTS.



By an ARTICULATION or JOINT is meant the fastening or joining together of the various bones of the skeleton.

Bone is the principal element entering into the composition of a joint.

CARTILAGE.— *Description.*— Firm, opaque, of a pearly-white or bluish-white color. In some varieties it is yellow, highly elastic, and readily yields to pressure.

Of *cartilage* there are two varieties,—that which constitutes the original frame work of the body, known as *temporary*, which, in time, becomes ossified throughout the greater part of its extent.

The *permanent* is that which remains unossified during the whole of life. Where this cartilage forms thin incrustations over the joint-surfaces of bones, it is known as *articular;* it also becomes a part of the solid framework of the body,— as the *costal cartilage.*

The *yellow* or *reticular* variety of cartilage is arranged in the form of plates or lamellæ of greater or less extent. Found in the external ear, nose, eyelids, eustachian tube, larynx, and windpipe.

LIGAMENTS are found in nearly all the movable articulations.

Function.—To connect together the articular extremities of bones.

Composition.— Mainly of bundles of *white fibrous tissue*, placed parallel with one another.

Properties.—Ligament presents a white, shining, silvery aspect. It is *pliant*, *flexible*, *strong*, *tough*, and *inextensile.* Some ligaments consist of *yellow elastic tissue*, as the *ligamenta subflava.*

Synovial membrane is thin, delicate, composed of white inelastic fibrous tissue, with a few elastic fibers, and lines the inner surface of the joint cavity.

Synovia.— Colorless, or of a pale yellowish tinge. It is viscid, like the white of an egg, and is a secretion of the syno-

vial membrane, being found in the joint cavity, intended for lubrication of the joint.

The *Synarthroses* are immovable joints, and are found between the bones of the skull.

SUTURA (a seam). — The *sutura harmonia* is found in the articulation between the two superior maxillary bones.

Coronal suture is between the frontal and parietal bones.

The *sagittal suture* is between the parietal bones, and its projecting articular processes are tooth-like in form.

Lambdoidal suture between the occipital and parietal bones.

Squamous or *scale-like suture* between the temporal and parietal bones.

A *Gomphosis articulation* is one where a conical process is inserted into a socket; as the teeth, in the alveolar processes.

Motions of Joints.—The simplest kind of motion that can take place in a joint is the *gliding movement.* It is common to all movable joints.

Angular movement, takes place in four directions,— forward and backward, constituting *flection* and *extension;* or inward and outward, constituting *adduction* and *abduction.* Found in the hip and shoulder.

[Definitions of the difficult words used in the diagram of *Articulations* will be found in the *Glossary,* at the close of this work.]

CHAPTER IV.

MUSCLES.

- MUSCLES
  - Definition.
  - Situation.
  - Formation.
  - Kinds of Muscular Tissue
    - Voluntary or animal life.
    - Involuntary or organic life.
  - Fasciculi.
  - Primitive fibrile.
  - Properties
    - Color.
    - Elasticity.
    - Contractility or Irritability.
    - Sensibility.
  - Divisions according to the arrangement of their fibers
    - Fusiform.
    - Radiate.
    - Orbicular or Sphincter.
    - Penniform.
    - Bipenniform.
  - Perimysium.
  - Blood-vessels.
  - How muscles are named.

The MUSCLES are the moving organs of the animal frame, and constitute what is known as the *lean meat* of the body. In a man, well proportioned, this system equals about two-fifths of the weight of the body.

Situation.—Around the bones in the limbs investing and defending them. In the *trunk*, they are spread out to inclose cavities and constitute a defensive wall.

Formation—Of bundles of reddish fibers. These *bundles* are inclosed in a delicate web of areolar tissue and consist of numerous smaller bundles, which are made up of *primitive fasciculi*. The *primitive fasciculi* consist of a number of filaments inclosed in a tubular sheath called the *sarcolemma*.

The *voluntary* or *muscles of animal life* are striped, and are under the control of the will. The *involuntary* or *unstriped muscles of organic life* are those not under the control of the will. They form sheets or membranes in the walls of hollow organs, and by contracting simply modify the capacity of the cavities which they enclose.

The primitive fibrils of the voluntary muscles are marked by *transverse striæ.* These *striæ* are also found in some of the *involuntary* muscles, but are not so distinct.

Color.—The *voluntary muscular tissue* is of a deep red color, while that of the involuntary muscle is paler and not so characteristic. The property of *irritability*, under normal conditions, is always present during life, and persists for a certain period after death.

A muscle detached from the living body continues for a time to respond, by contraction to proper stimulus.

By the *sensibility* of muscles imparted to them by the nerves, we are enabled to appreciate the power of resistance, immobility, and elasticity of substances with which we come in contact.

An *orbicular* or *sphincter* muscle is circular in outline, serving to contract the aperture to which it is attached. Examples: *Orbicularis pal-pe-bra-rum* and *sphincter oris.*

The muscles are abundantly supplied with blood-vessels.

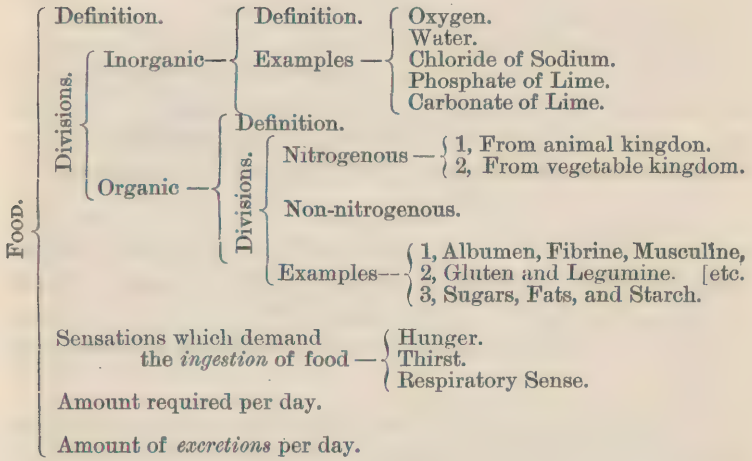
Muscles are named—1, from their situation, as the *tibialis anticus;* 2, from their direction, as the *rectus abdominis;* 3, from their uses, as *flexors*, *extensors*, etc.; 4, from their shape, as the *deltoid*; 5, from the number of divisions, as the *biceps* and *triceps*, which are *fusiform* muscles; 6, from their points of attachment, as the *sterno-cleido-mastoid.*

An *Aponeurosis* is an expansion of a tendon, or tendons, into a fibrous membrane.

Fascia (a bandage).—Found in all parts of the body, beneath the integument investing the muscular tissue.

CHAPTER V.

FOOD.



Under the name of ALIMENT or of FOOD are included all articles containing elements in a form enabling them to be used for the nourishment of the body. This may be done by the elements becoming a part of the organism, by merely assisting the process of nutrition, or by rendering disassimilation less speedy.

Oxygen is a transparent, colorless, odorless, and tasteless gas, forming about twenty per cent of the atmosphere, and by union with hydrogen forming water. Its rapid combination with bodies produces combustion; if this action takes place slowly, it is termed oxidation. It serves to support life, and is heavier than atmospheric air.

Water.—One of the most important and most abundant proximate principles of the organism, found in every *tissue* and *part*, without exception, introduced with all kinds of food.

It constitutes, by weight, four-fifths of the vegetable kingdom, and three-fourths of the animal kingdom.

Properties.—When pure, colorless, odorless, and nearly tasteless. "Pure water does not exist in nature."—*Flint.* It may be rendered pure by distillation.

Solvent Powers.—One pound of cold water will dissolve two pounds of sugar, two ounces of common salt, two and one-half ounces of alum, or eight grains of lime.

Amount required per day, about four and a half pounds.

Function of Water in the System.— In the *blood* it acts as a solvent for the salts and excrementitious matters. It gives to *cartilage* its elasticity, to *tendons* their pliability, and in *bones* it is necessary to their peculiar power of resistance.

Chloride of Sodium—where found.—By *mining*, by *evaporating* the water of salt springs; found also in sea water, which contains about four ounces in every gallon of water. Exists in *animal bodies. Excites the secretion of the digestive fluids.* An *adult* consumes about four and a half ounces per week.

Phosphate of Lime is found in all the solids and fluids of the body. It is the principal constituent of bone, where it exists in the proportion of about five hundred parts to the thousand.

Starch.—A non-nitrogenous principle, not crystallizable, is contained in abundance in a great number of vegetables. It is also found in the *cereals* (wheat, rye, corn, barley, rice, and oats), in leguminous plants (beans, peas, etc.), and in the sweet potato. It is most abundant in *rice*, which contains, after desiccation, about eighty-eight parts to the hundred.

Starch is converted into *sugar* by boiling with dilute acid, by contact with certain animal and vegetable juices, and by the process of nutrition and digestion.

Sugar, is converted into other substances by *fermentation.*

Fats— Varieties.—Oleine, *margarine*, and *stearine;* derived from both animal and vegetable sources. All are insoluble in water, but readily soluble in ether.

In the *adipose* tissue of the animal body the oils are found most abundantly.

Hunger.—A sensation which induces the ingestion of nutritive principles.

Situation.—A want of the general system. The *appetite* is *modified* by occupation, age, sex, climate, alcohol, tobacco, etc.

Thirst.—A special sensation which induces the ingestion of water. It can only be effectually relieved by fluids entering the circulation.

Modifications.—Occupation, febrile diseases, etc.

The Respiratory Sense is the want felt by the system which induces the respiratory movements.

[This sense will be discussed under the head of "Respiration."]

The length of time that life continues after complete deprivation of food and drink is very variable. In general terms, death occurs after from *seven* to *ten days* of total abstinence from food.

The amount of food required per day is greatly modified by habit, climate, the condition of the muscular system, age, sex, etc. Bearing in mind these facts, it may be stated that the adult male requires about *seven pounds* of ingesta a day.

The *Excretions* thrown off, consisting of urea, carbonic acid, water, salts, etc., amount to about seven pounds per day. The chemical results of change of tissue are modified by exercise.

[A remarkable case of long deprivation of food is reported at the close of the chapter on Digestion.]

CHAPTER VI.

DIGESTION.

- **Digestion.**
  - Definition.
  - Organs
    - Mouth
      - Situation.
      - Description.
      - Boundaries.
      - Lining membrane.
      - Gums.
    - Teeth
      - Temporary.
      - Permanent
        - Incisors.
        - Cuspids.
        - Bicuspids.
        - Molars.
      - Divisions of a Tooth
        - Crown.
        - Neck.
        - Fang.
      - Structure.
    - Tongue.
    - Salivary Glands
      - Parotid.
      - Submaxillary.
      - Sublingual.
    - Pharynx.
    - Œsophagus.
    - Stomach.
    - Intestines
      - Small
        - Duodenum.
        - Jejunum.
        - Ileum.
      - Large
        - Cæcum.
        - Ileo-cæcal Valve.
        - Ascending Colon.
        - Transverse Colon.
        - Descending Colon.
        - Sigmoid Flexure.
        - Rectum.
    - Liver.
    - Pancreas.
  - Juices of Digestion
    - Saliva
      - Description.
      - Specific gravity.
      - Composition.
      - Function.
      - How produced.
      - Amount per day.
    - Gastric.
    - Pancreatic.
    - Bile.
    - Intestinal.

    Notice the same points as in Saliva.

DIGESTION.— It is the process that the food undergoes in the alimentary canal, which reduces it to a form in which it can be absorbed and taken up by the blood-vessels.

ORGANS.— *The Mouth.*—At commencement of the alimentary canal, below the cavity of the nose. It is nearly an oval-shaped cavity, in which mastication takes place.

Boundaries.—*In front*, by the lips; *laterally*, by the cheeks and the ramus of the lower jaw; *above*, by the hard palate, *below*, by the tongue, and by the mucous membrane lining the floor of the mouth; *behind*, by the soft palate and fauces.

The *mucous membrane* lining the mouth is of a *rose-pink tinge.* At the free margin of the lips, it is continuous with the integument. Beneath this membrane and the *sphincter oris*, round the orifice of the mouth, are situated the *labial glands.* The *buccal glands* are placed between the mucous membrane and buccinator muscle.

Gums.— Composed of a dense, fibrous tissue, surrounding the necks of the teeth.

The Teeth.— An intelligent understanding of the *teeth*, both as to their anatomical and physiological relation to the human system, and a diligent care of the same, would save a vast amount of suffering. Serving as they do to properly prepare our food for digestion, give expression and symmetry to the features, proper articulation in speaking, their care and preservation becomes of the utmost importance. A word, then, as regards their structure, growth, cause of disease, and a few suggestions relative to their preservation, cannot fail, if heeded, to result in good.

The table below will indicate the period of eruption, and also the number of both first and second sets:

FIRST OR DECIDUOUS SET (20 IN NUMBER).

	NO.	MONTH.
Central Incisors	4	7th.
Lateral Incisors	4	8th.
First Molar	4	13th.
Canine — { Eye Teeth, Stomach Teeth, }	4	16th.
Second Molar	4	24th.

SECOND OR PERMANENT SET (32 IN NUMBER.)

	NO.	YEAR.
Anterior First Molar	4	6th.
Central Incisors	4	7th.
Lateral Incisors	4	8th.
Bicuspids	8	9th to 10th.
Canine — Eye Teeth, Stomach Teeth,	4	11th.
Second Molar	4	12th.
Third Molar (Wisdom)	4	17th to 25th.

Divisions of a Tooth — Crown. Neck. Fang.

Structure — Enamel. Dentine. Cementum.

The *crown* is the portion above the *gum*. The *neck* is embraced by the gum, and the *fangs* occupy the *alveolar sockets*. The largest portion of each tooth is composed of *dentine*. The crown is covered by *enamel*, the hardest structure in the body. Investing the dentine of the roots, is a thin layer of true bone, named *cementum*, *crusta retrosa*, or *cortical substance*. The lower teeth generally erupt a short time before the upper. Upon the proper treatment of the teeth, during first and second dentition, very largely depend the beauty and symmetry of the dental arch. Very much depends upon the diet during the eruptive period, as also perfect cleanliness of the mouth and teeth. It is of the utmost importance to see to the timely removal of a deciduous tooth, which may be impeding the growth of a permanent one, and very often it is of equal importance to preserve by filling, until the proper age for replacement by the permanent tooth. The wisdom teeth frequently give much pain during eruption, for want of room. They are early attacked with decay, in which event extraction is advisable.

The *Tongue* is a muscular sensitive organ, situated in the floor of the mouth. It serves many purposes, assisting in the prehension, mastication, and swallowing of food, being also an organ of taste, touch, and speech. The *frænum linguæ* (bridle of the tongue) is a fold of the mucous membrane lining the mouth at the under surface of the tongue. Children are said to be *tongue-tied* when the frænum is very short, or continued too far forward toward the tip of the tongue. Its

upper surface is covered with minute prominences, called *papillæ*, which are arranged in lines.

The *muscles of the tongue* are the *genio-hyo-glossus*, *hyo-glossus*, *stylo-glossus*, and *lingualis*.

The *function of the tongue*, in mastication, is to prevent the escape of the solid food from between the teeth, and by its constant movement to roll the food over and over, passing it at times from one side to the other, so that it may undergo thorough trituration. After mastication has been completed, the mouth is closed, and the tongue, with the bolus of food behind it, is pressed from before backward against the roof of the mouth. By this movement, the food is passed backward to the isthmus of the fauces.

In man, the tongue is attached at its base, and along the mesial line on the under surface, while its apex is free and movable. In the frog, the tongue is rooted in front, and and free behind It is very extensile, covered with a slimy, viscid mucus, and is used in procuring food. It is thrown forward with great rapidity, thus enabling the frog to seize its prey, which is quickly swallowed, without mastication.

The Salivary Glands are the *parotid*, *submaxillary*, and *sublingual*. These glands communicate with the mouth, and pour their secretions into its cavity.

The *Parotid Gland* is situated in front of and below the external ear. It is the largest of the salivary glands, and weighs from half an ounce to an ounce. Its fluid passes into the buccal cavity through *Steno's duct*, which is about two and a half inches in length, and opens by a small orifice opposite the second molar tooth in the upper jaw. This duct is about the size of a crow's-quill.

The *Submaxillary Gland* is situated below the inferior maxillary bone, in the anterior part of the submaxillary triangle of the neck. It is smaller than the parotid, but its minute structure is the same. Its excretory duct, called *Wharton's*, is about two inches in length, and opens beneath the tongue in a small papilla by the side of the frænum.

The *Sublingual Glands* are situated under the tongue, beneath the mucous membrane of the floor of the mouth, and on either side of the frænum. They are the smallest of the salivary glands. Here we find a number of excretory ducts, from eight to twelve in number, which open into the mouth by the side of the frænum.

SALIVA.—A thick, glairy, and generally frothy and turbid, fluid.

Specific gravity, from 1002 to 1007.

Composition.—Water, 995.16; epithelium, 1.62; organic matter, 1.34; chloride of sodium, chloride of potassium, etc.

The secretions of the various salivary glands are all transparent, yet the mixed saliva, as it comes from the buccal cavity, is a grayish, viscid, mucus, containing a number of *leucocytes* and *epithelial scales*. These characters are given to it on account of the secretions of the labial, buccal, and lingual glands, which form a constant and essential part of the mixed saliva. During sleep, the discharge of fluid into the mouth is much diminished. Upon the introduction of food, the quantity of saliva is enormously increased. The *sight*, *odor*, and, at times, even the *thought*, of agreeable articles, will produce a notable increase in the flow of saliva.

Amount per day, about two and a half pounds. The quantity of saliva must necessarily be subject to great variations, and it should be remembered, however, with reference to this and the other digestive secretions, that this immense quantity of fluid is at no one time removed from the blood, but is reabsorbed nearly as fast as secreted, and in a normal condition none of it is discharged from the organism.

Functions.—First, to moisten the food, and to assist in mastication and deglutition. Second, to convert starch into sugar; though this is done in ordinary digestion only to a limited degree. The saliva has also a remarkable tendency to entangle bubbles of air in the alimentary mass. The abundant secretion of the parotid glands becomes most completely incorporated with the food during mastication, while

the secretions from the submaxillary and sublingual glands, being more viscid and less in quantity than the parotid secretions, have a tendency to form a glairy coating on the exterior of the alimentary mass, thus facilitating deglutition.

PHARYNX.—Placed behind the mouth and larynx, and extends from the under surface of the skull to the fifth cervical vertebra. It is a musculo-membranous sac, in form somewhat conical, the apex downward and the base upward, and about four and a half inches in length. At the upper part of the anterior wall of the *pharynx*, just behind the uvula, are two large apertures—the *posterior nares*,—while the *eustachian tubes* open, one at each side, of the upper part of the pharynx.

Coats.—The *mucous coat*, which is continuous with that lining the eustachian tubes, nares, mouth, and larynx; the *muscular coat;* and the *fibrous coat*, which is placed between the mucous and muscular layers.

ŒSOPHAGUS.—Reaches from the pharynx to the stomach, or from opposite the fifth cervical vertebra to the tenth dorsal vertebra, and in the adult is about nine inches in length.

Coats.—The œsophagus has an *external* or *muscular* and an *internal* or *mucous coat.* The *mucous coat* is connected to the *muscular* by fibrous tissue, and may be termed a *third coat.* The *muscular coat* is composed of two layers of muscular fibers, an *external longitudinal* and an *internal circular layer.* The longitudinal fibers shorten the tube, while the circular fibers, by a progressive peristaltic contraction from above downward, propel the food into the stomach.

STOMACH.—In man, the most dilated portion of the alimentary canal, and is somewhat conical or pear-shaped. It is situated in the upper part of the abdominal cavity, with its greater or splenic end toward the left side of the body. It is held in its position by folds of the peritoneum and by

the œsophagus. When empty, it is flattened, and its opposite walls in contact.

Length—When moderately distended, about twelve inches; its widest *diameter*, about five inches.

Capacity, about five pints.

The *orifices* or *openings* of the stomach are two in number, —the *œsophageal* or *cardiac*, communicating with the œsophagus, and the *pyloric*, communicating with the duodenum.

Coats.—1, *Serous*—Derived from the peritoneum. 2, *Muscular*—Consisting of three sets of fibers—(*a*) *longitudinal*, (*b*) *circular*, (*c*) *oblique*. 3, *Cellular*—Connects the mucous and muscular coat. 4, *Mucous*—Thick, surface smooth, soft and velvety; *color*, during adult life, a pale straw or ash-gray.

In the mucous coat are found the *gastric* or *peptic glands*. Mucous glands are also found in the lining membrane, which, during the intervals of digestion, constantly cover it with a thin, transparent, viscid mucus. On the introduction of food into the stomach, the lining membrane changes its appearance from a pale to a distinctly red color, drops of gastric juice begin to appear in various parts, and gradually increase in size, until the fluid may be seen trickling down the sides in small streams.

Gastric Juice.—Clear, a faint yellowish or amber tint, almost colorless, with a *sour* taste and odor. Specific gravity, 1005 to 1009.

Composition.—Water, 975.00; mineral matters, about five per cent; organic or "ferment," also called *pepsin*, about 17.00; free acid, about 3.00.

Amount secreted per day, about fourteen pounds.

Function.—Digests the *albuminoid substances*.

Duration of Stomach Digestion.—It is now understood that the stomach is not the most important organ of digestion. Comparatively few articles are completely dissolved in the stomach, so that less interest is attached to the length of

time required for the action of the gastric juice upon different articles of food than formerly. While the time varies in different individuals, and is modified by the kind and quantity of food taken, conditions of the nervous system, exercise, etc., yet the average duration of food in the stomach after an ordinary meal may be said to be from two to four hours.

Vomiting.—This act, as a rule, is preceded by nausea, also by an increase in the flow of the saliva. It is not an action of the stomach, but of the muscles of the abdominal cavity. While the action takes place, the cardiac orifice is dilated, and the contents of the stomach pressed upon by the contraction of the abdominal walls in an expiratory effort. These acts cause the contents of the stomach to be ejected through the œsophagus and the mouth.

The most important division of the digestive system is the *Small Intestine.* It extends from the pyloric extremity of the stomach to the *ileo-cæcal valve*, and is held to the spinal column by the *mesentery*, a double fold of the peritoneum. In this part of the alimentary canal the food is converted into chyle, and is mixed with the bile, pancreatic juice, and the intestional secretions. The length of the intestine, *in situ*, is from fifteen to twenty feet; its diameter is about one and a quarter inches.

The *Duodenum*, so called from the fact that it is about the length of twelve finger breadths, is from eight to ten inches in length.

The *Jejunum*, usually found empty after death, includes the upper two-fifths of the rest of the small intestine; the remaining three-fifths, called the *Ileum* (to twist), forms numerous coils or convolutions.

Coats of Small Intestine.—*Serous*, *muscular*, and *mucous.* The *serous coat* is derived from the peritoneum.

The *muscular coat* consists of two layers of fibers,—an external or longitudinal and an internal or circular, both of which are concerned in the peristaltic movement of the intestine.

The *mucous coat* is highly vascular, soft and velvety in appearance, and its color, during digestion, is a vivid red. It is folded upon itself,—the folds called the *valvulæ conniventes.* We find in it also the *glands of Brunner*, or *duodenal racemose glands; follicles of Lieberkuhn*, or *intestinal tubules;* the *intestinal villi*, *solitary glands*, and *agminated glands* or *Peyer's patches.*

Intestinal Juice.—Colorless and glassy in appearance, viscid, with an alkaline reaction. Secreted by the follicles of Lieberkuhn and the glands of Brunner.

Function.—Converts starch into sugar and aids the general process of digestion as it takes place.

Liver.—The largest gland in the body. Situated principally on the left side of the body, in the abdominal cavity, close to the diaphragm.

Weight.—From three to four pounds, or fifty to sixty ounces avoirdupois.

Diameter.—Transverse, from ten to twelve inches; *antero-posterior*, from six to seven inches.

Structure.—The substance of the liver is made up of *lobules*, of a somewhat ovoid or rounded form, and about one-twenty-fifth of an inch in diameter. Between the lobules, in the inter-lobular spaces are found blood-vessels, nerves, and ramifications of the *hepatic duct*, all enclosed in a fibrous sheath.

Functions of the Liver.—The secretion of bile and the formation of sugar.

The vessels distributed in the liver are—the *portal vein*, the *hepatic artery*, and the *hepatic duct*—which enter at the transverse fissure. The vessels coming from the liver are the *hepatic veins*, which originate in the lobules.

The *hepatic duct* is formed by the union of two ducts, one from the right and the other from the left lobe of the liver. It is about an inch and a quarter in length, and joins with the *cystic duct.* The *common duct* is about three inches in length, of the size of a goose-quill, and enters the duodenum.

The Gall-Bladder.—An ovoid or pear-shaped sac, the reservoir for the bile.

Length, about four inches; *breadth*, about one inch at its widest portion.

Capacity, from eight to ten drachms.

Held in its position by the peritoneum. It communicates with the common bile duct by the cystic duct, which is about an inch in length.

Bile.—Somewhat viscid, the *color* varying according to the species of animal from which it is taken. It is also variable within the limits of health of the same animal. In man it has a dark, golden-brown color. It is usually dark green in the carnivora, and greenish yellow in the herbivora. Specific gravity of human bile is about 1018. It has an excessively bitter taste, and a soap-like foam when shaken in a test tube.

Coloring Matter.—*Bilirubin* or *biliverdine.*

Amount per day, about two and a half pounds. The discharge is continuous, but very much increased during digestion.

Function.—While the function of the bile in digestion is essential to life, very little is known of its mode of action. In cases where the bile is kept out of the duodenum of the inferior animals, there is in the processes of digestion and absorption a most serious interference, and a rapid loss of strength. Emaciation, and finally inanition, follow, when there is a persistence in the exclusion of bile from the system.

Pancreas.—A glandular organ, situated transversely in the upper part of the abdominal cavity. It is narrow and flattened in shape, with an enlarged thick portion,—called the *head*—a body, and a pointed extremity. The head is attached to the duodenum.

Length, from six to eight inches; greatest *breadth*, about an inch and a half; *weight*, from four to five ounces.

Pancreatic Juice.—A clear, colorless, somewhat viscid

fluid, with a specific gravity of 1008 to 1010. The most important ingredient is the organic matter or *pancreatine.*

Amount per day, about one and three-fourths pounds.

Function.—Digests the fats and converts starch into sugar.

The following remarkable case of abstinence from food is reported by Drs. Cowperthwaite & Caldwell, of Iowa City:

"Miss Hattie Deuell, a resident of Iowa City, aged fifty-two years, ate her last meal Wednesday noon, February 23d, 1881. She died on the afternoon of April 11th, not having tasted food for a little more than forty-seven days. Clear water was freely drank during the whole period. Insanity was the cause of her fast. The autopsy revealed thickening, congestion, and minute perforations of the dura mater on the vertex over the longitudinal sinus. Albumen-like clots were found in the arachnoidean space, and softening of a spot as large as a walnut in the right half of the posterior lobe of the brain. Extensive adhesions of the pleuræ existed, as also did hepatization in different portions of both lungs. Another item worthy of notice, though not necessarily associated with the dementia or the fast, was the peculiar shape of her stomach. It presented two clearly-defined large pouches, of nearly equal size; the one at the pyloric end being somewhat larger than that usually called the greater pouch."

During the whole period of starvation above reported, there was no muscular exertion, and water was freely taken, which circumstances have an important influence in prolonging life. For several years prior to the commencement of Miss Deuell's fast, she had been confined to her bed, and on one occasion had deprived herself of aliment for a period of three weeks.

It is stated that death from starvation usually occurs after a loss of four-tenths of the weight of the body. Hence, when a man weighing one hundred and fifty pounds, has, by abstinence from food, reduced his weight to ninety pounds, death occurs.

CHAPTER VII.

ABSORPTION.

- ABSORPTION
  - Definition.
  - Processes
    - Endosmosis.
    - Exosmosis.
    - Imbibition.
  - Organs
    - Blood-vessels.
    - Villi.
    - Lacteals.
    - Receptaculum-chyli.
    - Thoracic duct.
    - Lymphatic Glands.
  - Fluids
    - Lymph.
    - Chyle.
  - Causes of the movements of Lymph and Chyle.

ABSORPTION is the process by which the digested materials are taken into the blood.

Endosmosis and *exosmosis*, *liquid diffusion*, or *osmotic action*, are properties of animals and vegetable membranes. If water and alcohol, two liquids which are capable of mixing with each other, be separated by an animal membrane, the one liquid being suspended in a bladder in the other, the liquid in the bladder will pass through the bladder into the other, giving *exosmosis*, or the liquid without will pass into the bladder giving *endosmosis*. Both actions will take place at the same time. Plants absorb carbonic acid gas principally through the *stomata* of their leaves, and both by the upper and under surface of the leaf. They also derive nourishment from their roots, absorption taking place most rapidly at the extremities of their fibrils. The latter process may be termed *capillary attraction* or *endosmosis*. The phenomena of endosmosis and exosmosis are due to the attraction that different liquids have for each other, and for the membrane separating them.

Imbibition is a property common to all animal structures, by which the membrane itself is capable of taking up a certain portion of the liquid, and may be considered the starting point of absorption. All solutions are not imbibed by the tissues with the same degree of activity.

The *Villi* are the active agents of absorption. They are conical vascular eminences, thickly set over the whole internal surface of the lining membrane of the small intestine. On the external surface of a *vilus* is found a layer of epithelial cells, then a plexus of blood-vessels, and in the central part of the vilus, originating by a blind extremity, is the commencement of the *lacteal tube.*

The *Lacteals* are the lymphatics of the small intestines, and pass through several sets of lymphatic or mesenteric glands on their way to the receptaculum-chyli. They absorb the fatty matters from the intestinal canal. The fluid they contain, during the intervals of digestion, and also that found in the thoracic duct at this time, is ordinary lymph; but, during digestion, certain nutritive principles are taken up by these vessels, and their contents are known as *chyle.* This is a white, opaque, milky fluid, with a specific gravity less than that of the blood. When it is removed from these vessels, it speedily undergoes coagulation.

The *Receptaculum-chyli* is situated upon the front of the body of the second lumbar vertebra, and is simply a dilatation of the lower end of the thoracic duct.

The *Thoracic Duct* extends from the second lumbar vertebra to the root of the neck. Through the first part of its course, it lies in front of the bodies of the vertebræ; but opposite the fourth dorsal it inclines toward the left side, and ascends behind the arch of the aorta to the left side of the œsophagus. Opposite the upper border of the seventh cervical vertebra, it curves downward, forming an arch terminating in the left subclavian vein, near its angle of junction with the internal jugular.

The great majority of the lymphatic vessels empty into the *thoracic duct.* Its walls are exceedingly delicate; the diameter of the vessel is about that of a goose-quill. Near its termination is a pair of semilunar valves, which effectually prevent the entrance of blood from the venous system.

The *Right Lymphatic Duct* is a short trunk, about an inch in length. It carries the lymph from the right side of the head and neck, right trunk, right upper extremity, and empties it into the right subclavian vein at its point of junction with the right internal jugular vein.

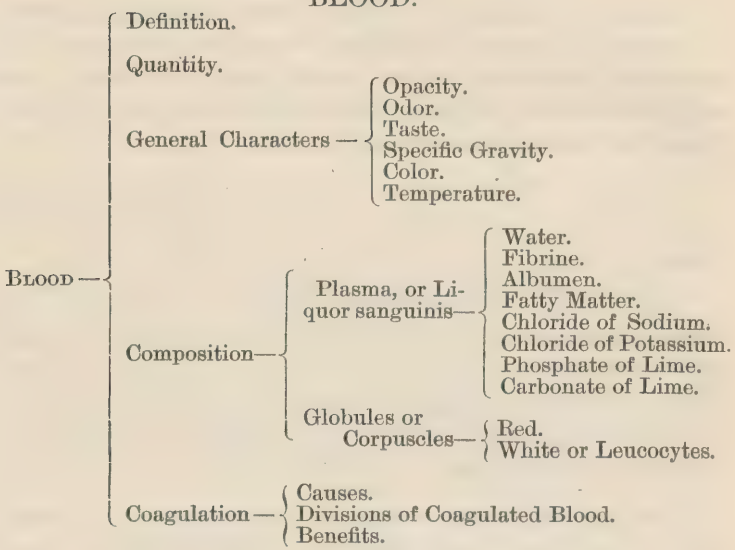
Lymphatic Vessels are so delicate, and their coats so transparent, that the fluid they contain is readily seen through them.

Lymphatic Glands are small, flattened, oval bodies, varying in size from a bean to a pin-head. The lymphatic vessels pass through these glands on their way to the great lymphatic trunks. Those vessels which enter the gland are known as *vasa afferentia*, and those leaving the gland as *vasa efferentia.* In its interior, the gland is soft and pulpy.

Causes of the Movements of Lymph and Chyle.—1, Influence of the forces of endosmosis and transudation. 2, Influence of the contractile walls of the vessels. 3, Influence of pressure from surrounding parts. 4, Influence of the movements of respiration.—*Flint.*

CHAPTER VIII.

BLOOD.



The Blood is a circulating, nutritive fluid, and the most abundant and complex of the animal fluids.

Quantity.—It is a difficult matter to estimate, with absolute precision, the amount of blood in the human body; but as the result of various experiments given by Flint and Dalton, the weight of the blood, in proportion to the entire weight of the body, is as one to eight. In the body of a healthy man, weighing one hundred and thirty-five pounds, would be found, therefore, on an average, fifteen pounds of blood.

General Characters.—The blood, while circulating in its normal condition in the vessels, is an opaque fluid, consisting of elements having different refractive powers.

Odor.—Faint, but characteristic. By adding to a speci-

men of blood a few drops of sulphuric acid, the odor peculiar to the animal from which the blood is taken is brought out and becomes very marked.

Taste.—On account of a small portion of chloride of sodium found in its composition, the blood has a faintly saline taste.

Specific Gravity.—Defibrinated, from 1052 to 1057 (Robin). Different conditions of digestion have much to do with the variations of its density.

Color.—Varies from a brilliant scarlet to a dark purple, and is due to the corpuscles contained in it. The coloring matter of the red corpuscles is termed *hæmaglobine.* In the arteries the blood is usually red; in the veins generally dark blue,—the principal exception being the pulmonary circulation.

Temperature.—The normal temperature is generally given as from ninety-eight to one hundred degrees Fahrenheit, although it varies considerably in different parts of the body. Benard found the highest temperature of the blood in the hepatic veins, where it ranged from one hundred and one to one hundred and seven degrees Fahrenheit.

Globules or Corpuscles—red.—Constitute a little less than one-half of the mass of blood. They give the blood its red color and its opacity. They are *circular*, *biconcave*, *flattened disks*, with edges thicker than the center. They have the property of *elasticity*, so that if their form is changed by pressure they immediately resume it again when the pressure is removed.

Diameter—Of human globule, about one-thirty-five-hundredth of an inch; of the horse, one-four-thousandth; pig, one-forty-two-hundredth; cat, one-four-thousandth; dog, one-forty-one-hundred-and-fiftieth. Number of globules in a cubic millimeter, about four million.

Function.—The presence of the red corpuscles enables the blood to absorb from ten to thirteen times as much oxygen as an equal bulk of water. The tissues of the body are con-

stantly absorbing oxygen and giving off carbonic acid. A very important function of the red corpuscles is to carry oxygen to all the tissues. This is their principal work, although, to some extent, they take up carbonic acid, which takes the place of the oxygen after the blood has been brought by the capillaries into contact with the tissues.

White Corpuscles or Leucocytes.—Found also in lymph, chyle, pus, etc. Are much larger than the *red* corpuscles. Irregular in form. Have a tendency to adhere to the walls of blood-vessels, moving along slowly, sometimes remaining entirely stationary. Their number, as compared to the *red*, is as one to four hundred.

Diameter, about one-twenty-five-hundredth of an inch.

Function, not understood.

Coagulation is the thickening of the blood into a jelly-like mass.

Causes.—But little is known as to the cause of the coagulation of the blood. Coming directly in contact with the atmosphere, the blood coagulates, but it will also coagulate in a vacuum. It coagulates if there is a stoppage of circulation; but when removed from the body, and violently agitated, or if artificial circulation is kept up, it still coagulates. Lowering of the temperature is said to cause coagulation; and yet, if sufficiently lowered, it prevents it. Circumstances which favor exposure of the blood to the air seem to hasten coagulation; hence, the blood flowing slowly from a small orifice coagulates more rapidly than when it comes in a full stream from a large orifice. If placed in a shallow vessel, it coagulates much more rapidly than when placed in a deep vessel. If the sides of the vessel are uneven or rough, it coagulates more rapidly than if they are smooth or polished. If the blood be allowed to flow on a cloth or a bundle of twigs, it coagulates almost instantaneously.

DIVISIONS OF COAGULATED BLOOD.

First—Clot, containing — { Fibrine, / Red Corpuscles.

Second—Serum—Containing all which do not belong to the clot.

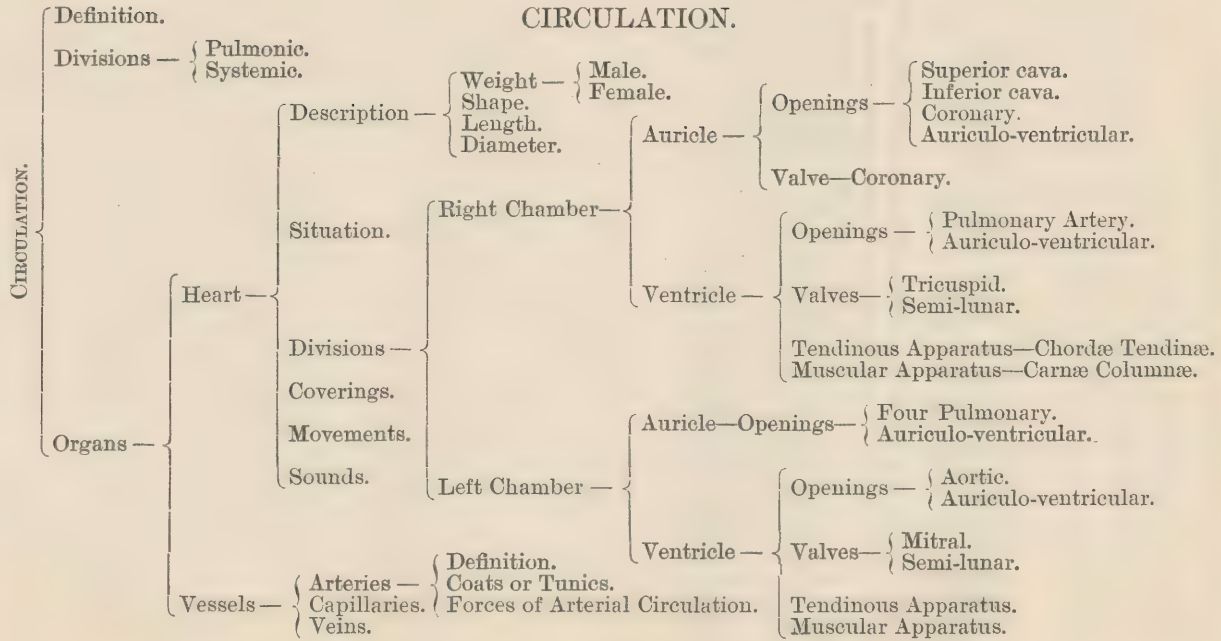
Benefits.—It arrests hemorrhage, and thereby often saves life.

The blood cannot coagulate while the normal circulation is maintained, and while it is undergoing the constant changes which are necessary to the healthy nutrition of the body.

The teacher may obtain a specimen of blood from a slaughter-house, and placing it in a glass goblet, allow it to coagulate into a jelly-like mass. It can then be turned upon a plate and cut into halves. The external surface of the clot will be a dark color, while on its interior it will be a bright red, becoming darker by contact with atmospheric air. To show the fibrine, take a portion of the clot and whip it with a bunch of twigs, when the fibrine will adhere to the twigs in the form of white shreds. This is a simple process, and will enable the pupil to get a good idea of coagulated blood.

CHAPTER IX.

CIRCULATION.



CIRCULATION was discovered by Harvey, in 1616.

Definition.—It is the continuous circuit of the blood through the blood-vessels to the entire system, and is the means of transportation of the elements necessary for the construction of the tissues.

In the *pulmonic* or *lesser circulation* the blood passes from the right ventricle through the pulmonary artery to the lungs, and returns through the pulmonary veins to the left auricle of the heart.

In the *systemic* or *greater circulation* the blood passes from the left ventricle to the aorta; from thence to all parts of the system, through the arteries and capillaries, collected by the veins, and by them returned to the right auricle of the heart.

The HEART is a hollow muscle, and the great central organ of circulation. From it there is a constant flow to all the tissues and organs of the body, and a constant return of the blood to it after passing through these parts.

The *weight of the heart* in the male is from ten to twelve ounces, and in the female from eight to ten ounces. In proportion to the weight of the body in the male as 1 to 169, and in the female as 1 to 149.

Shape.—The heart is pear-shaped or in the form of a cone, with the apex pointing downward and forward, the base or larger end pointing upward and backward and to the right.

Length, about five inches. *Diameter*, about four inches.

The under surface is flattened, and rests upon the tendinous portion of the diaphragm. The upper side is rounded and convex.

Situation.—In the thoracic cavity, the base about the median line, and the apex at the fifth intercostal space, about two inches to the left of the sternum.

Divisions.—The partition between the two chambers of the heart is called the *septum*. In man the heart is double,—the chambers on the one side are entirely distinct, and sep-

arated from those on the other. The action, however, of the two sides is simultaneous. At the same time that the blood is sent from the right side to the lungs, it is also sent from the left side to the system.

In the *outline*, the *openings* of the chambers of the heart are given. If the pupil becomes familiar with the names of the veins which enter the auricles, and of the arteries which originate at the ventricles, it is an easy matter to remember the names of the openings of the different cavities.

All orifices into the heart, and all communications between chambers, are guarded by valves, except where the venæ cavæ and the pulmonary veins enter the auricles. The valves of the heart are so arranged that the current of blood is always in one direction.

Tricuspid Valve.—*Situation*—At right auriculo-ventricular opening.

Shape.—It has three points, being composed of three segments or triangular-shaped curtains. These curtains are attached at the base around the opening, while the free borders are attached to the chordæ tendineæ. These, in their turn, are attached to the columnæ carneæ, which are the rounded muscular columns projecting from nearly the whole of the inner surface of the ventricle.

Mitral Valve.—This is sometimes called the *bicuspid valve.* It is situated at the left auriculo-ventricular opening. In structure and arrangement it presents no difference from the tricuspid valve; but, as its name implies, it has two curtains instead of three.

The *Aortic Semilunar Valves* are situated at the opening of the aorta. They somewhat resemble a half-moon or crescent, and are attached around the opening of the aorta. They are strong, membranous pouches, with their concavity opening toward the aorta. During the contraction of the aorta, their free margins meet in the center, and prevent the regurgitation of the blood.

The *Pulmonic Semilunar Valves.*—In structure similar

to those of the aorta, are situated at the opening of the pulmonary artery, during the contraction of which they oppose the regurgitation of the blood into the right ventricle.

Action of the Mitral and Tricuspid Valves.—The auricular systole, which, when completed, distends the ventricles to their utmost capacity, is immediately followed by the systole of the ventricles. During the passage of the blood through the auriculo-ventricular openings, the valves are open, and at the first part of this action they hug closely the walls of the heart, thus offering no obstruction to the free passage of the blood from the auricle to the ventricle; but, as this action is completed, and the ventricles entirely dilated, the valves are floated out, and by the systole of the ventricles are closed, so that no regurgitation can take place toward the auricles.

Coverings.—The heart is enveloped in a fibrous membrane called the *pericardium*. Like all other serous membranes, it is a shut sac. It is attached above to the great vessels, about two inches above their origin from the base of the heart. It is lubricated by a drachm or two of fluid, which serves to facilitate the movements of the heart, within the pericardium. The lining membrane of the heart is termed the *endocardium*.

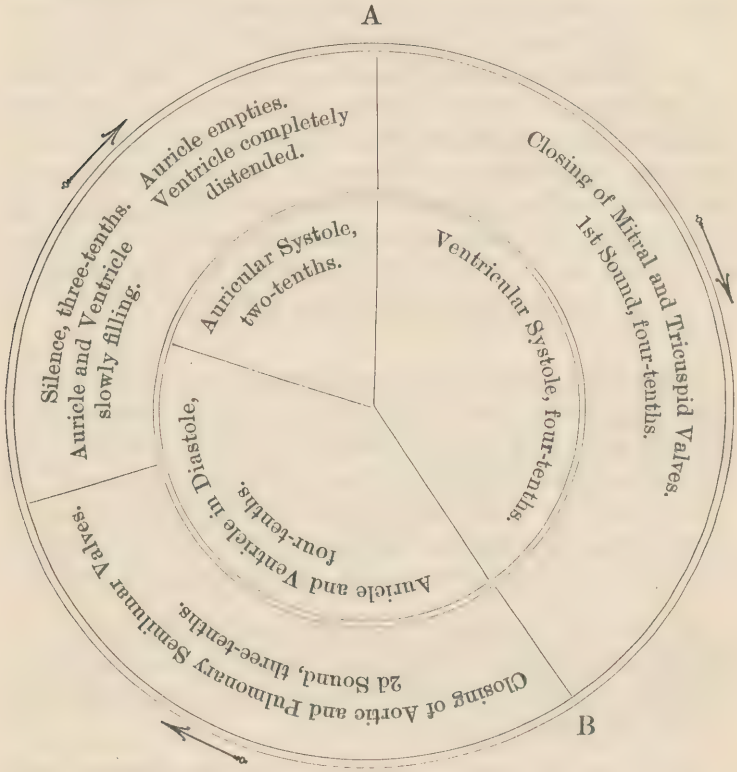
Movements.—*Diastole* or *dilitation*, which is mostly a passive act, and *systole* or *contraction* an active movement. A *revolution* of the heart is the filling and emptying of all of its cavities including the period of repose.

Sounds.—The *first sound* is exactly simultaneous with the beating of the apex of the heart against the walls of the chest. It is long, low, dull, and booming in tone. It has three elements,—*first*, a valvular element caused by the closing of the mitral and tricuspid valves; *second*, a muscular element, which is due to the heart as a muscle; *third*, the beating of the apex of the heart against the walls of the chest.

The *second sound* is high, quick, and sharp in tone. It occurs during the ventricular diastole of the heart. It has

but one *element*, which is purely valvular, caused by the closing of the aortic and the pulmonary semilunar valves.

A careful study of the following diagram will assist the student in understanding the heart's sounds, and their relations to the diastole and systole of the heart.



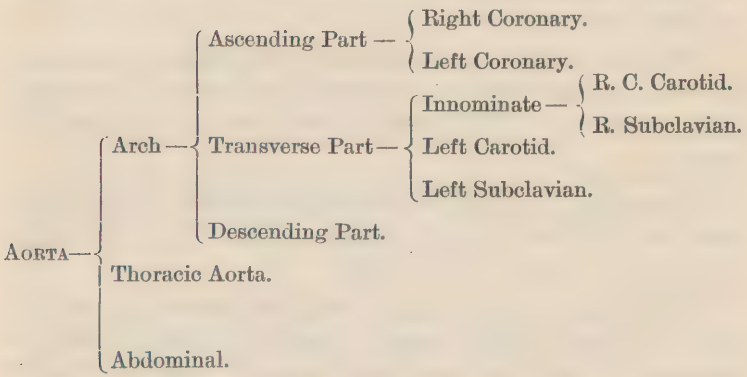
There are eight abnormal sounds of the heart. A *mitral* and *tricuspid regurgitant*, which would occur during the ventricular systole.

The mitral and tricuspid direct may occupy the entire time from B to A with the greatest intensity during auricular systole.

Pulmonary and aortic *regurgitant* occur during the second sound—usurp its place. Pulmonary and aortic *direct* occur during ventricular systole.

CHAPTER X.

ARTERIES.



The *Aorta* arises at the upper part of the left ventricle of the heart. From its origin it passes upward for a short distance, then arches backward to the left side, descends on the left side of the vertebral column, passes through the aortic opening in the diaphragm, and in the abdominal cavity opposite the fourth lumbar vertebra divides into the right and left common iliac arteries. The common iliacs are about two inches in length, and divide into two branches—the internal and external iliac arteries—supplying blood to the walls of the abdomen, the pelvis, and lower extremities. From the arch of the aorta are given off, first, the right and left coronary arteries, which convey blood to the substance of the heart. The next branch of the aorta is the *innominate*, which divides into the right subclavian and right common carotid. The subclavian supplies blood to the upper extremity, and the carotid is distributed to the neck and head, supplying not only the muscular tissue, but also the inner surface of the sensorium and the brain.

The ARTERIES are cylindrical tubes, or tubular vessels, which convey the blood from both ventricles of the heart to every part of the body. They are strong, highly elastic, and dense in structure. When empty they preserve their cylindrical form.

The arteries have three *coats* or *tunics* — *Internal serous* or *epithelial coat*, *middle fibrous* or *circular coat*, and an *external cellular coat.*

When an artery is cut, the blood flows from it in intermittent jets, caused by the pulsations of the heart. The wave-like movement of the blood in the arteries is termed the *pulse.*

Causes of the Circulation in the Arteries.—The primary cause of the motion of the blood in the arteries is the contraction (*vis a tergo*) of the heart.

The *Elasticity of the Arteries* have much to do with the flow of blood through them. The aorta, being elastic, is distended during the ventricular systole, and then reacts, after the distending force ceases, and compresses its fluid contents. The aortic semilunar valves instantly close, which renders regurgitation with the heart impossible. The influence, then, can only be exerted onward toward the capillaries. The arteries are also *contractile*, which is another force of the circulation of the blood through these vessels. The small vessels, by virtue of this power, regulate the distribution of the blood.

CAPILLARIES.

The CAPILLARIES are connecting links between the arteries and veins, being continuous with the terminal ramifications of the arteries on the one hand, and with the commencing rootlets of the veins on the other. They have but a single coat or tunic, which is a continuation of the inner coat of the arteries. Their average diameter in the human is about one-three-thousandth of an inch. They are smallest in the ner-

vous and muscular tissue, where they are from one-six-thousandth to one-four-thousandth of an inch in diameter. The capillaries form a true plexus of vessels branching and inosculating in every direction. Their *function* is to bring the blood into intimate contact with the substance of the tissues, so that its fluid portions slowly transude through the walls of the vessels, and are absorbed by the tissues in such proportion as is requisite for their nourishment.

VEINS.

After the blood has been brought into contact with the tissues by the capillary system, it is then collected by the VEINS and carried to the auricle of the heart.

The *Pulmonary Veins*, four in number, return the blood from the lungs to the left auricle. They carry arterial instead of venous blood. They are destitute of valves.

Systemic Veins return the blood from the body generally, to the right auricle of the heart.

The *Portal Vein*, found in the abdominal cavity, conveys the blood from the abdominal viscera to the liver. This may be called the *portal venous system*. The superior mesenteric, inferior mesenteric, and splenic veins unite to form one large trunk called the *vena portæ*, which enters the liver, and ramifying its substance, emerges from that organ by the hepatic veins, three in number, which enter the inferior vena cava,—this vessel terminating in the right auricle of the heart.

Superficial or Cutaneous Veins.—These veins return the blood from the integument and superficial structures. They pass inward, and terminate in the deep veins.

Deep Veins.—Situated among the deeper structures of the body, convey the blood from the capillaries of the deep structures.

The veins have *three coats*—an *internal homogeneous membrane*, which is continuous with the single coat of the capillaries; a *middle fibrous coat*, and an *external coat*. The external coat is composed of white fibrous tissue.

The *Valves of the Veins* are little membranous folds, or reduplications of the middle and inner coats, semilunar in form, similar to the aortic and pulmonary valves. Usually they are arranged in pairs; sometimes, however, they are found in groups of three, and, occasionally, but one is found at a place.

Function.—The great function of the valves is to prevent a reflux of the blood toward the capillary system. When circulation is arrested, from any cause, in the veins, the valves offer an obstruction, which tends to force the blood onward toward the heart.

The following named veins have no valves: Venæ cavæ, hepatic, portal, pulmonary, and common iliac. Valves are also absent in the very small veins.

The great motor power which is the consequent of the *constant* and *steady* flow of the blood through the veins, is the contraction of the heart.

Muscular Contraction is one of the principal causes of venous circulation. In order that this be a force to assist the flow of blood through the veins, two things are essential—the contraction must be intermittent, and there must be no possibility of a retrograde movement. The action of the thorax in respiration exerts a suction force operating on the veins in the immediate neighborhood of the chest.

The blood makes the entire circuit of the body in about twenty-three seconds. After death, the arteries are found empty, and all the blood in the body accumulates in the venous system and the capillaries.

CHAPTER XI.

RESPIRATION.

- RESPIRATION
  - Definition.
  - Organs —
    - Larynx —
      - Vocal Cords.
      - Cartilages —
        - Thyroid.
        - Cricoid.
        - Arytenoid.
        - Epiglottis.
    - Trachea.
    - Bronchi.
    - Bronchial Tubes.
    - Lungs —
      - Definition.
      - Situation.
      - Divisions —
        - Right.
        - Left.
      - Weight.
      - Color.
      - Tissue.
      - Structure —
        - External Serous Coat.
        - Sub-serous Areolar Tissue.
        - Pulmonary Substance.
    - Pleuræ —
      - Pleura Pulmonalis.
      - Pleura Costalis.
    - Auxiliary Organs.
  - Movements —
    - Inspiration.
    - Expiration.
  - Kinds of Respiration —
    - Abdominal.
    - Thoracic.
  - Volumes of Air —
    - Residual.
    - Reserve.
    - Tidal.
    - Complemental.
  - Changes in the Air during Respiration.
  - Changes in the Blood during Respiration.

Definition.—RESPIRATION is the act by which the various tissues receive and appropriate oxygen, and by which the venous blood is arterialized and renovated.

ORGANS.—*Larynx*, the organ of the voice, situated at upper and fore part of the neck, between the trachea and base of the tongue. It is somewhat conical in form, with the base or broad extremity above.

The *Vocal Cords* extend across the superior opening of larynx from before backward. The *superior* or *false vocal cords* are not concerned in the production of the voice. The *inferior* or *true vocal cords* are attached anteriorly at the middle of the thyroid cartilage, posteriorly to the movable arytenoid cartilages. The true vocal cords are composed largely of elastic fibers, and are covered by a delicate, thin, and closely adherent mucous membrane. The opening between the vocal cords is called the *rima glottidis.*

Cartilages.— *Thyroid* (a shield)—Consists of two lateral portions united in front, forming a projection which is quite prominent above, and called the *pomum Adami*, or Adam's apple. The posterior borders terminate above in the superior cornua, and below in the inferior cornua.

Cricoid Cartilage, resembling, a signet ring. It is thicker and stronger than the thyroid cartilage, being placed below it, and is narrow in front and broad behind.

Arytenoid Cartilages are so called from their resemblance to the mouth of a pitcher, and are situated on the posterior part of the larynx, at the upper border of the cricoid cartilage.

Epiglottis.—A leaf-shaped organ, composed of yellowish fibro-cartilage. It is placed behind the tongue, being attached to the anterior portion of the larynx. During ordinary respiration, the epiglottis projects upward, its free extremity curving toward the base of the tongue. During the occurrence of deglutition, when, for the time, respiration is interrupted, the epiglottis is carried backward, completely closing the opening of the larynx.

Trachea or Air-Tube.—A cartilaginous and membranous cylindrical tube. It extends from the fifth cervical vertebra to opposite the third dorsal, the length being about four and a half inches, and the diameter from three-quarters of an inch to an inch. The cartilagineous rings, which extend about two-thirds around its cylinder, are from fifteen to twenty in number, and leave an imperfect space behind,

which is filled up with fibrous tissue. In the chest the trachea divides into the *right* and *left bronchi.* The right bronchus is about an inch in length, and is made up of from six to eight cartilages. The left bronchus is about two inches in length, and contains from nine to twelve cartilages. The primitive bronchi, after penetrating the lungs, break up into numerous ramifications called the *bronchial tubes.* The walls of the trachea and bronchial tubes are lined with a mucous membrane, in which are found numerous mucous glands. This lining membrane is smooth, covered by ciliated epithelium,—the cilia always moving from within outward.

The *Lungs* are the chief organs of respiration, and are placed one in each lateral half of the thoracic cavity. They are separated by the heart and the mediastinum. Each lung is conical in shape, with the apex upward, and extending about an inch above the first rib; the base is broad, somewhat concave, and rests upon the diaphragm. The weight of both right and left lung is about forty-two ounces, the right being about two ounces heavier than the left. The right lung has three lobes, and is larger and broader than the left; the left lung has two lobes, and is narrower and longer that the right.

The *Color of the Lung*, at birth, is of a pinkish-white; in adult life it is mottled in patches of a dark slate color, and the surface is smooth and shining.

The *Tissue of the Lung* is of a light, porous, spongy texture. It is highly elastic and floats in water.

If a portion of lung substance be taken between the fingers, and pressed upon, a crackling or rattling sound is produced, on account of the cells being broken up, and the air contained in them escaping.

The *External Coat* invests the entire lung, and is thin and transparent. It is derived from the pleura.

The *Sub-serous Areolar Tissue* is somewhat elastic, in-

vesting the entire surface of the lung, and is found extending inward between the lobes.

The *Parenchyma* or *Pulmonary Substance* of the lung, is made up of lobules, varying in size. In each lobule is found one of the ramifications of the bronchial tube, with its accompaning air cells. The air cells are about one-seventy-fifths of an inch in diameter, and are separated from each other by a thin septa. They open into the spaces or air sacs between the cell walls. The spaces communicate with the lobules, and the lobules with the bronchial tubes. All these ramifications of the bronchi are lined with a thin, delicate, mucous membrane.

Pleura. — An exceedingly delicate serous membrane, which completely encloses each lung as far as its root, where it is reflected upon the inner surface of the thorax. This is called the plura. It is divided into two layers,—the *pleura pulmonalis*, which is the portion next to the surface of the lung, and is also called the *visceral layer;* the second layer is the *pleura costalis*, or *parietal layer*, and lines the inner surface of the chest. Between these two layers is found a cavity or space, which is termed the *cavity of the pleura.* The pleuræ of the lungs are separated from each other by a fold or duplicature of the pleura of each lung. This septum completely divides the cavity of the thorax into two parts,—the *right half* containing the right pleural sac, and the *left half* the left pleural sac. These two sacs do not communicate with each other. In the cavity of the pleura is found a serous fluid, which serves to lubricate the inner surface of the membrane, and gives to it a smooth and polished appearance.

The *Auxiliary Organs of Respiration*, in man, are the *diaphragm* and *ribs* and *intercostal*, *sub-costal*, and *abdominal muscles.*

The *Diaphragm* is a musculo-fibrous partition, in form of a vaulted arch or dome, between the thoracic and abdominal cavities. It is concave below and convex above. In an ordinary respiration, the diaphragm descends, approximating to

a plane; in its downward movement it pushes before it the viscera of the abdominal cavity, thereby causing a protrusion of the abdomen. The diaphragm is supplied by the *phrenic nerve*, which arises from the third and fourth cervical nerves, receiving a communicating branch from the fifth. From this origin it descends to the root of the neck, passes through the chest, penetrates the diaphragm, and is distributed to its under surface. The section of this nerve almost completely paralyzes this muscle.

As the ribs are elevated by the action of the muscles, the thoracic cavity is enlarged. The seven true ribs are attached to the vertebræ behind, and, by the intervention of the costal cartilages, to the sternum in front. From their origin they pass outward, forward, and downward, and as they are elevated and become more nearly horizontal, they push forward the lower end of the sternum, thereby increasing the antero-posterior diameter of the thoracic cavity.

Movements of Respiration.— Inspiration is the act by which the lungs are filled with air, and is effected by the descent of the diaphragm and the elevation of the ribs.

An ordinary *Expiration* is a simple and nearly a passive process, by which the air is expelled from the lungs.

Surrounding the air cells of the lungs are found a great many elastic fibers, which give to the lung tissue a great degree of elasticity. The lungs are encased in an air-tight cavity. If they are removed, they immediately collapse, becoming many times smaller than the cavity in which they are contained.

The walls of the thoracic cavity are also very elastic. After the muscles concerned in inspiration have ceased their action, the elasticity of the costal cartilages and the tonicity of the muscles will restore the chest to its passive dimensions. Expiration, then, depends upon the passive influence of the elasticity of the lungs and thoracic walls, also upon the action of certain muscles, by which the ribs are depressed, and the dimensions of the chest are diminished.

Kinds of Respiration.—In children under three years of age, respiration is chiefly carried on by the diaphragm, and is termed the *abdominal type of respiration.* At a variable period after this age, a difference in the kinds of respiration in the sexes begins to show itself. In the male, the abdominal type is predominant, and continues through life. In the female, the thoracic type predominates. This distinction in the sexes becomes apparent at about the age of maturity. Different writers have designated different stages in the life of man. Perhaps the most usual division is the five periods, as follows:—

1. *Infancy*, extending to about the seventh year, or to the second dentition.

2. *Childhood*, extending from the seventh to the fourteenth or fifteenth year.

3. *Adolescence*, or *Youth*, reaching, in males, from about the age of fifteen to twenty-five; in females from thirteen to twenty-one.

4. *Adult Age*, or *Manhood*, extending from the close of youth to about the fiftieth year.

5. *Old Age*, which includes the declining portion of life.

Volumes of Air.—The lungs, together with the heart, great blood-vessels, and other organs, completely fill the cavity of the chest. By the contraction of certain muscles, the cavity of the thorax is enlarged. This causes the pressure of the air to be greater on the outside than on the inside, consequently the air rushes through the trachea into the lungs, until the pressure on the outside is equal to the pressure on the inside.

A respiration includes both the inspiratory and expiratory act.

The amount of air changed at an ordinary expiration and inspiration is call the *tidal* or *ordinary breathing air.*

During a forced expiration, a certain amount of air is expelled over and above that of an ordinary expiration; this

is the *reserve* or *supplemental air*. But, after a forced expiration, a considerable quantity of air (the *residual air*) still remains in the lungs. It is because the lungs, in a natural condition, are partly distended, and that they are placed in the air-tight chest, that this amount of air cannot be expelled. If, by a puncture of the chest-walls or diaphragm air is introduced into the pleural chamber, the chest ceases to be air-tight, and the air thus admitted causes a partial collapse of the lungs, and forces out a considerable portion of the residual air through the windpipe.

There is also an excess over the ordinary breathing air (the *complemental air*) which may be introduced by a forcible inspiration.

In a healthy adult male, the residual and the reserve air each amount to about one hundred cubic inches, the tidal air to twenty cubic inches, and the complemental air to one hundred and ten cubic inches. This makes the *lung capacity* amount to three hundred and thirty cubic inches. Deducting the residual air, gives the *extreme* or *vital breathing capacity*.

The frequency of the respirations vary according to age, sex, muscular exercise, condition of the nervous system, etc., the average number, however, as determined from the most numerous and convincing collection of facts, is from eighteen to twenty-four per minute. There seems to be a relation of the respiratory acts to the pulse, which in health is quite constant. This proportion, as a rule, is one respiratory act to every four pulsations of the heart. During sleep, the number of respiratory acts is diminished.

Composition of the Atmospheric Air.—In all climates, in the darkness, as well as in the sunlight, everywhere about us, existing all over the earth's surface, is found a mechanical mixture of oxygen and nitrogen in just the proportion to enable it to sustain life. In this mechanical mixture, the oxygen forms about twenty-one parts and the nitrogen about seventy-nine parts. It is a question of great physiological interest to determine the quantity of oxygen which is removed from the air by the process of respiration. The air, when

taken into the system, contains about twenty-one parts of oxygen to the hundred; when it is exhaled, it contains only about sixteen parts to the hundred. This would make the volumn of oxygen absorbed in the lungs five per cent, or one-twentieth of the volume of air inspired. If the number of respirations per minute be eighteen, and the ordinary breathing air be twenty cubic inches for each respiratory act, then eighteen cubic inches of oxygen are consumed in one minute, which represent three hundred and sixty cubic inches of pure air. Continuing our calculations, we find, that, in twenty-four hours, fifteen cubic feet of oxygen are consumed, representing three hundred cubic feet of pure air. In cases of ventilation, or the regulation of the supply of oxygen for churches, school-houses, hospitals, or wherever many persons are assembled, these facts are of inestimable value. Besides the loss of oxygen during respiration, there is also a marked elevation in the temperature of the air after it has passed through the lungs.

While the air in the respiratory act has given up oxygen it has gained in carbonic acid, so that the expired air contains about four per cent more carbonic acid than the inspired air. This amount, however, is greatly modified by age and sex, activity or repose of the digestive system, form of diet, sleep, muscular activity, etc. The expired air contains *watery vapor*, which is derived from the entire surface traversed in respiration.

Changes of the Blood in Respiration.—As the blood is passing from the arteries to the veins, its color changes from a bright red to a dark purple. This change is due to the physiological decomposition of the tissues. In the lungs its color changes again to a bright red, which is due to the action of the air. While the blood is coming in contact with the tissues, it gives up its oxygen, and becomes impregnated with carbonic acid; it also loses some of its important constituents,—hence venous blood is not so rich in organic and most inorganic elements. Arterial blood contains a larger proportion of corpuscles and is more coagulable than venous blood.

The Respiratory Sense.—Breathing, under ordinary conditions, takes place without our knowledge; but if there is an interruption in the respiratory process, there immediately follows a distressing sense of suffocation. It has been demonstrated, that, if the want of air felt by the system be effectually supplied, the respiratory movements will not take place. The respiratory sense operates upon the respiratory nervous center, and gives rise to the involuntary movements of respiration. Recent experiments lead to the conclusion that the sense of want of air is due primarily to a deficiency of oxyginated blood in the medulla oblongata. The respiratory acts will still take place if all the encephalic centers, except the medulla oblongata, are destroyed.

VITAL OR ANIMAL HEAT.

Limit of Variation in Normal Temperature of Man.

In the *axilla*, the maximum temperature is about 99.5 degrees; the minimum about 97.7 degrees.

Under the tongue, about 98 degrees.

Variations in Different Parts of the Body.

Aorta, 98¾ to 105½ degrees.

Portal Vein, 100.04 to 106.34 degrees.

Hepatic Vein, 99.86 to 107 degrees.

Average temperature of body, from 98 to 100 degrees.

Variations at Different Periods of Life.

During Infancy, 1 to 2 degrees more than in adult life.

During Adult Life, 98 to 100 degrees.

During Old Age, about one-half degree below adult life.

Diurnal Variations in the Temperature of the Body.

Periods of maximum — { Eleven A. M. / Four P. M.

Minimum, always at night.

During the periods of digestion, there is a slight increase in the temperature of the body. Under all conditions of climate the general heat of the body is equalized.

By *Animal Heat* is meant the persistent and uniform elevation of temperature. The absence of this heat is an indication of death. So important is this to the animal economy, that but slight variation from the normal temperature is possible without producing serious derangement.

Alcohol seems always to produce a fall in temperature.—*Foster.*

The use of alcohol does not enable men to endure a very low temperature for a great length of time.—*Flint.*

Dr. Hays, a scientific Arctic explorer, says: "While fresh animal food, and especially fat, is absolutely essential to the inhabitants and travelers in Arctic countries, alcohol is, in almost any shape, not only completely useless, but positively injurious."

Exercise, as in fast walking or riding, produces a constant elevation in the general temperature, amounting to between one and two degrees. This elevation, according to Flint, is produced in the muscular tissue itself. That the heat of the body is regulated by the perspiration is proven by the fact, that, if the skin is covered by an impenetrable coating, death occurs in a very short time. Such a coating covers up the pores of the skin, so that its function is suppressed, followed by a lowering of the animal temperature.

CHAPTER XII.

NERVOUS SYSTEM.

- **Nervous System.**
  - Purpose.
  - Anatomical divisions of Nervous Tissue —
    - Nerve Cells.
    - Nerve Fibers.
  - Organs —
    - Nerves —
      - Definition.
      - Divisions of a Single Nerve —
        - Axis Cylinder.
        - Myeline.
        - Neurilemma.
      - Plexus.
      - General divisions of Nerves —
        - Cerebro-spinal or Nerves of Animal Life.
        - Sympathetic or Nerves of Organic Life.
      - Divisions of Nerves according to place of origin —
        - Cranial —
          - Special Sense.
          - Motion.
          - General Sensibility.
        - Spinal —
          - Mode of origin.
          - Divisions —
            - Cervical.
            - Dorsal.
            - Lumbar.
            - Sacral.
            - Coccygeal.
    - Ganglia.
    - Cerebro-spinal Center or Axis —
      - Brain.
      - Spinal Cord.

Purpose of the Nervous System.—To produce the harmonious action of the different organs of the body.

Nerve Cells.—Parts capable of generating nerve force.

Nerve Fibers act only as conductors.

Nerves are round, flattened cords, connecting the *cerebro-spinal center* with the ganglia and the various textures of the body, and by which sensation, volition, or vital influence is conveyed to and from the sensorium.

General Divisions.—*Cerebro-Spinal or Nerves of Animal Life.*—Distributed to the organs of the senses, the skin, and the active organs of locomotion—the muscles.

Sympathetic or Nerves of Organic Life.—Distributed chiefly to the viscera and blood-vessels. Each nerve is composed of *motor* and *sentient fibers.* The motor fibers convey stimulus from within outward; the sentient fibers, from without inward.

Parts of a Single Nerve.—The *Axis-Cylinder* exists in all the nerves, and is the central, thread-like portion, the diameter of which is about one-half or one-third that of the tube in which it is contained.

The *Myeline* is the medullary substance filling the tube and surrounding the central band. It is a transparent, semi-fluid, and homogeneous medulla.

The *Neurilemma* is the tubular sheath surrounding the axis-cylinder and myeline.

A *Plexus* or *Network* is the communication or intertwining and intercrossing of nerves.

Cranial Nerves, so called because they take their origin in the brain and pass out from the cranial cavity.

ANATOMICAL AND PHYSIOLOGICAL CLASSIFICATION OF THE CRANIAL NERVES.

Special Sense.

- First Pair — Olfactory; the special nerve of smell.
- Second Pair — Optic; the special nerve of sight.
- Seventh Pair — Auditory or Portio Mollis; the soft root of the Seventh, and the special nerve of hearing.

Nerves of Motion.

- Third Pair — Motor Oculi Communis; a nerve of motion of the eyeball.
- Fourth Pair — Patheticus; motor nerve.
- Sixth Pair — Abducens.
- Seventh Pair — Facial or Portio Dura; hard root of the Seventh, and sometimes called the nerve of expression.
- Ninth Pair — Hypoglossal; motor nerve of the tongue.

Nerves of General Sensibility.

- Fifth Pair — Trifacial; general sensibility of the face.
- Eighth Pair — Glosso-pharyngeal, Pneumogastric and Spinal Accessory; three mixed nerves.

SPINAL NERVES.—There are thirty-one pairs of spinal nerves,—eight cervical, twelve dorsal, five lumbar, five sacral, and one coccygeal. Each spinal nerve takes its origin from the spinal cord by two roots,—an anterior (motor) and a posterior (sensory) root. Upon each posterior root is developed a ganglion of an oval form. Just beyond this ganglion the two roots unite in a single mixed nerve, and leave the spinal canal through the intervertebral foramen. The nerve thus formed divides into two branches,—*anterior* and *posterior*,—both containing motor and sensory filaments.

That part of the body in front of the spine, including the limbs, is supplied by the *anterior branches*. These are larger than the posterior branches, each nerve is connected by a slender filament to the sympathetic. The anterior branches in the cervical, lumbar, and sacral regions form plexuses prior to their distribution.

The *posterior branches* are distributed to the muscles and integument behind the spine.

All the cerebro-spinal nerves anastomose with the sympathetic.

The *Sympathetic System* consists of *ganglia* and *nerves*.

The *ganglia* are arranged in the form of a double chain, on either side of the spinal column, running parallel with one another until they reach the sacrum, when they converge and communicate together in front of the coccyx through the ganglion impar.

The sympathetic filaments are generally distributed to mucous membranes, to the fibers of the involuntary muscular tissues, and particularly to the muscular coat of the arteries. The general process of nutrition is influenced by the sympathetic. It also seems to have a controlling power over the secretions.

A *Ganglion* is an enlargement or a knot in the course of a nerve, composed of the vesicular neurine, distinct from the brain and spinal cord.

SPINAL CORD.

- Spinal Cord —
  - Situation.
  - Membranes or Tunics —
    - Dura Mater.
    - Arachnoid.
    - Pia Mater.
  - Sub-Arachnoid Space.
  - Cerebro-Spinal Fluid.
  - Length.
  - Weight.
  - Fissures.
  - Columns.
  - Structure.
  - Function.

The Spinal Cord is situated in the spinal canal, and is continuous with the brain. It is cylindrical in form, and does not fill the canal in which it is contained.

Membranes.— *Dura Mater.*—A loose covering or sheath which surrounds the cord, and is not adherent to the bones. This membrane is attached to the margin of the foramen magnum, and is continuous with the dura mater of the brain. It consists of white fibrous tissue, and is sparingly supplied with blood-vessels.

Arachnoid.—A thin, delicate, serous membrane. Consists of a *parietal*, or outer, and a *visceral*, or inner, layer. It invests the outer surface of the cord, and is reflected upon the inner surface of the dura mater.

Pia Mater.—A delicate vascular membrane, continuous with the pia mater of the brain.

The *Sub-Arachnoid Space* is situated between the inner layer of the arachnoid and the pia mater. In this space is contained the *cerebro-spinal fluid*, which is perfectly transparent, colorless, and free from viscidity. If this fluid is evacuated, it is speedily reproduced.

Length.—The spinal cord is from eighteen to twenty inches in length, commencing at the foramen magnum and extending to the first lumbar vertebra. Its *weight* is about an ounce and a half. The cord terminates below the first lumbar vertebra with a slender gray filament which is called the *filum terminale.*

Fissures.—The *Anterior Median Fissure* is wider but not as deep as the posterior, and penetrates the anterior portion of the cord for about one-third of its thickness.

The *Posterior Median Fissure* is deeper than the anterior, and extends into the cord to about one-half of its depth.

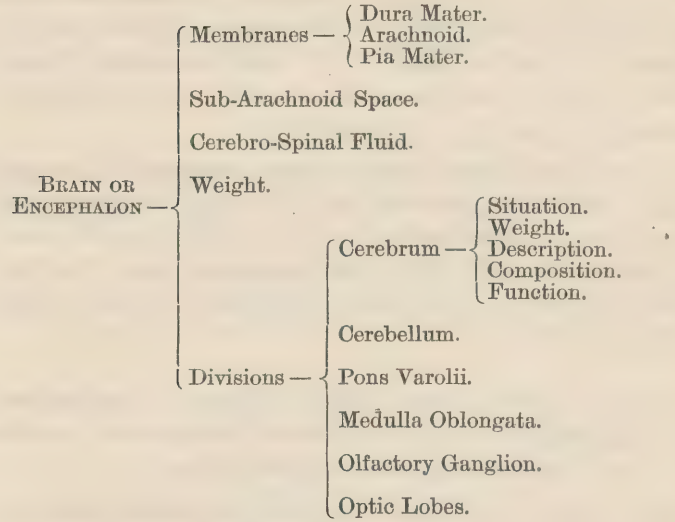
These fissures divide the cord into two lateral halves. Each half of the cord is divided into an anterior, lateral, and posterior *column;* the lateral column is included between the origin of the anterior and posterior roots of the spinal nerves.

Structure.—The spinal cord consists of *gray* and *white nervous matter.* The *white substance* constitutes the greater part, and is situated externally. The *gray substance* occupies the center, and is in the form of two crescents, their convex surfaces connected by the gray commissure.

The spinal cord conveys to and from the brain efferent and afferent impulses, and is the means of communication

between the body and the sensorium. It is also a ganglionic center, and is capable of receiving and transmitting impressions. It is, therefore, the center of pure reflex action.

BRAIN.



The *Dura Mater* is a dense, fibrous membrane. It lines the interior of the skull, and is intimately adherent to the inner surface of the cranial bones. It is composed of two layers, which at certain situations become separated and form the venous sinuses. This membrane also sends prolongations or processes inward, for the support and protection of different parts of the brain. One of these descends vertically in the longitudinal fissure between the two hemispheres of the cerebrum, and is called, from its shape, the *falx cerebri.* Another is formed between the cerebrum and cerebellum, and is known as the *tentorium cerebelli.* At the border of the foramen magnum the dura mater is closely attached to the bone.

The *Arachnoid Membrane* is a delicate serous coat. Like other serous membranes it is a shut sac, and consists of a parietal and a visceral layer. This membrane does not follow the convolutions and fissures of the brain, but merely covers their surfaces. Between it and the pia mater is found the sub-arachnoid space. This space contains the cerebro-spinal fluid. The chief use of this fluid, as far as known, is to afford protection to the nerve centers, and by equalizing the pressure in the varying condition of the blood-vessels, to serve as protection to the cerebro-spinal axis.

Pia Mater.—A vascular membrane, consisting of a minute plexus of blood-vessels. It invests the entire surface of the brain, dipping down between the convolutions and laminæ.

Weight of the Brain, in the *male*, average, about 49½ ounces; *female*, average, 44 ounces. Up to the sixth or seventh year, the weight of the brain increases rapidly—after this period more slowly, until about the fortieth year, when it reaches it maximum. The human brain is heavier than that of any of the lower animals, except the elephant and the whale. The brain of the former sometimes approximates nine or ten pounds, and of the latter about five pounds.

Divisions.—*Cerebrum.*—Situated in the upper and anterior portion of the cranial cavity, occupying the anterior and middle fossæ of the base of the skull. It is separated from the cerebellum by the tentorium. It constitutes about four-fifths of the encephalic mass. Its upper surface is ovoidal in form, broader behind than in front. This surface is covered by tortuous eminences or *convolutions*, separated by the *sulci* or furrows, depressions of various depths,—generally about one inch.

The cerebrum is divided by the *longitudinal fissure* into *right* and *left hemispheres* or lateral halves. The sides of the longitudinal fissure form the inner surfaces of the cerebrum. The two hemispheres are connected by the *corpus callosum*, which is a broad, transverse commissure of white matter.

The dura mater does not dip down between the convolutions of the cerebrum.

The cerebrum is composed of *gray* and *white matter.* The *Gray Matter*, or cortical substance, is situated externally, follows the convolutions, and is from one-twelfth to one-eighth of an inch in depth. This layer of gray matter in each of the principal divisions of the brain is continuous, there being no anatomical division between its different parts. It also follows the cerebral surfaces of the great longitudinal fissure throughout its entire length. The gray matter is composed of a mass of nerve cells, and hence is capable of generating nerve force.

The *White Matter* is situated internally, and is made up of fibers or nervous filaments, running nearly parallel with each other.

The function of the *Nerve Fibers* is to transmit or conduct impressions which are to be received by a nervous center or a ganglion. This center may again send out impulses by the nerve fibers which are conducted to distant organs.

Function of the Cerebrum. — There can be no intelligence without brain-substance, hence destruction of brain-substance produces loss of intellectual power. The cerebral hemispheres preside over the intellectual faculties, of memory, judgment, reason, etc.,—*i. e.*, they are the instruments through which these faculties act, or manifest themselves. If these instruments be imperfect in structure or be injured by disease or in any manner whatever, the operations of the intellectual faculties must be correspondingly impaired.

Cerebellum (*or little brain*).—Situated at the posterior part of the cranial cavity beneath the posterior lobes of the cerebrum. Its weight is from five to seven ounces. It is oblong and flattened from above downward. The surface of the cerebellum is traversed by numerous curved furrows or sulci, varying in depth at different parts. The gray matter of the cerebellum is somewhat darker than that of the cerebrum, and is

situated externally. In proportion to its size the cerebellum contains a much larger quantity of gray matter than the cerebrum. Its *function* is the power of associating or co-ordinating the different voluntary movements.

If, from a pigeon, the cerebellum be removed, all power of assuming or retaining any natural position is gone. His actions, which are voluntary in character, are altogether irregular and confused. In the human subject, any sudden injury inflicted upon the cerebellum is immediately followed by a disturbance of the co-ordinating power.

The *Pons Varolii* (Bridge of Varolius) is situated above the medulla and between the hemispheres of the cerebellum. It is a band of union of the different parts of the brain, connecting the cerebrum above, the medulla below, and the cerebellum behind. This ganglion is connected with the functions of sensation and voluntary motion.

The *Medulla Oblongata* is the upper and expanded part of the spinal cord, resting on the basilar groove of the occipital bone, and extends from the upper border of the atlas to the lower border of the pons. It is pyramidal in form, with its broad extremity upward.

Length, about one and one-fourth inches; *breadth*, three-fourths of an inch at widest part; *thickness*, one-half inch.

At the middle and posterior portions of the medulla is found the nucleus of gray matter, called the *nucleus of the pneumogastric*, from which the pneumogastric nerve takes its origin. So essential is this part of the brain to the preservation of life, that it has received the name of the *vital knot*, and destruction of it is immediately followed by death.

The medulla serves as a conductor of sensory impressions and of motor stimulus to and from the brain. It also presides over the functions of respiration.

The *Olfactory Ganglion* is situated at the side of the crista galli, on the cribriform plate of the ethmoid bone. It

is oblong, of a gray color, and soft in texture. It is composed of a grayish-white substance. From its under surface are given off from fifteen to twenty nervous filaments, which pass through the ethmoidal foramen and are distributed to the mucous membrane of the nose.

The *Optic Lobes*, or *Tubercula Quadrigemina*, are situated at the base of the cerebrum, immediately behind the third ventricle. They consist of four small rounded eminences, placed in pairs,—the two in front being largest, and of a grayish color externally. All the lobes contain gray nervous matter in the interior.

The *Optic Nerves* take their principal origin in the optic lobes.

SLEEP.

Sleep may be defined as that state of the body in which the functions of sensation and volition are suspended, and the operations of the mind, if not at perfect rest, are disconnected with external objects. Although there is a modification in the vital functions, the two most important muscular acts, viz., those concerned in circulation and respiration, are never entirely interrupted. All animals possessing a well-developed nervous system, must, time after time, obtain that rest which brings a renewal of the vital force expended by the activities of the mind or the body. It is evident that a study of this condition is important, when we remember that about one-third of our lives is spent in sleep. Anything causing an excessive expenditure of the so-called nerve force, such as continued and severe mental exertion, or long and vigorous muscular effort, makes sleep an imperative necessity. When the nervous system is not over-excited, sleep follows moderate effort as a natural consequence, and it is the only real brain rest. No torture is more severe nor more refined than long-continued deprivation of sleep. Physicians recognize sleeplessness as one of the most important predisposing causes of

certain brain diseases. As a rule, we sleep less in summer than in winter.

Sleep is preceded by certain well-known phenomena; first, a feeling of drowsiness is experienced, and also an indisposition to mental or physical exertion; the muscular system becomes relaxed, the eyelids close, we no longer appreciate the ordinary impressions of sound, and pass into a dreamless condition, in which all knowledge of our existence is lost.

No active mental exercise should be indulged in just before retiring to rest. Let the hour of retiring be preceded by something which does not require the expenditure of severe mental force, as some light reading, some innocent game, or pleasant conversation. If possible, before retiring, banish all thought of the arduous labors of the day, and the obstacles which may have presented themselves, thus inviting a natural and healthy cessation of the activity of mind and body.

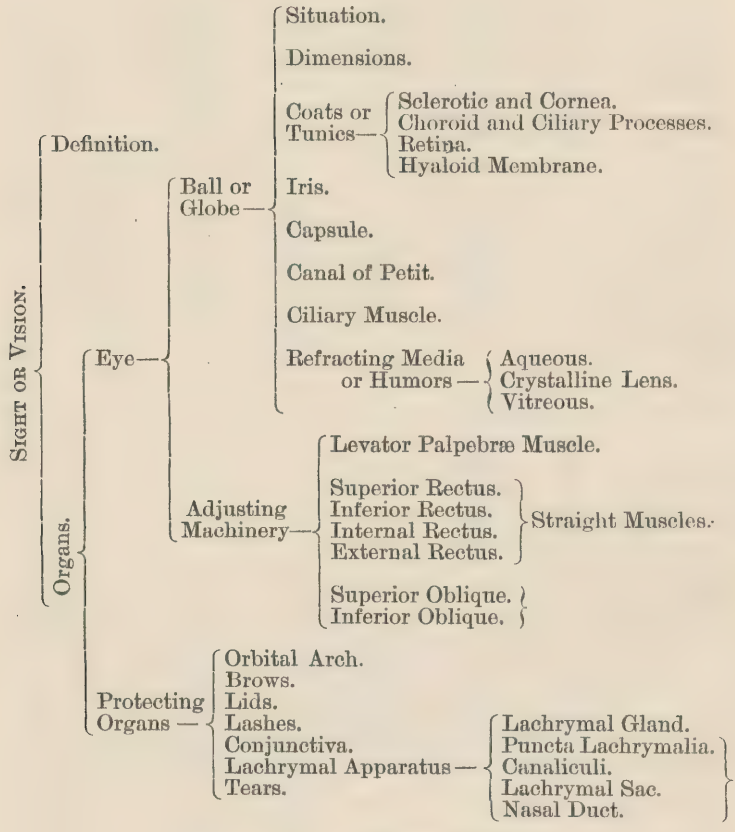
TABLE OF CRANIAL NERVES.

Name.	Origin.	Foramen Transmitted.	Branches.	Distribution.	Remarks.
1st — Olfactory.	Inferior and internal portion of the anterior lobe of the cerebrum. Corpus Striatum. Island of Reil.	Ethmoidal.	From the Olfactory Bulb, about twenty in number.	Mucous membrane of the nose.	Gray matter in interior—Soft and pulpy.
2d — Optic.	Optic thalami. Tubercula Quadrigemina.	Optic.	None.	Retina.	Perforated by the arteria centralis retinæ.
3d — Motor Oculi Communis.	Crus Cerebri. Valve of Vieussens.	Sphenoidal fissure.	Superior. Inferior.	All the muscles of the eye-ball, except the External Rectus, and Superior Oblique.	
4th — Patheticus or Trochlear.	Floor of fourth Ventricle. Valve of Vieussens.	Sphenoidal fissure.	A recurrent.	Superior Oblique Muscle.	

5TH — Trifacial.	Lateral portion of the Pons Varolii. Lateral tract of the Medulla, just behind the olivary body. Gasserian ganglion.	1st division thro' Sphenoidal fissure. 2d division thro' Foramen Rotundum. 3d division thro' Foramen Ovale.	Ophthalmic. Superior Maxillary. Inferior Maxillary.	The great sensitive nerve of the face.	
6TH — Abducens.	Posterior part of the Medulla. Floor of fourth Ventricle.	Sphenoidal fissure.	None.	External Rectus muscle.	
7TH — Auditory.	Floor of fourth Ventricle.	Meatus Auditorius Internus.	Cochlear. Vestibular.	The parts of the internal ear.	Destitute of Neurilemma.
7TH — Facial.	Floor of fourth Ventricle; also lower border of the Pons Varolii.	Stylo-mastoid.	Numerous.	Muscles of expression of face; also Platysma and Buccinator.	
8TH — Glosso-pharynges	A nucleus of gray matter at lower part of floor of the fourth Ventricle.	Jugular.	Carotid, pharyngeal, muscular tonsilar, lingual.	Pharynx, fauces, tonsil, and tongue	A nerve of sensation, of motion, and of special sense.
8TH — Pneumogastric.	Lower part of floor fourth Ventricle.	Jugular.	See outline.	Organs of Voice and Respiration. Pharynx, Œsophagus, & Stomach.	Composed of motor and sensitive fibers.
8TH — Spinal accessory.	Lower half of the Medulla Oblongata. Upper two-thirds of the cervical portion of the Spinal Cord.	Jugular.	Internal or Anastomotic. External or Muscular.	Muscles of the Neck.	The internal branch communicates with the Pneumogastric.

CHAPTER XIII.

SIGHT OR VISION.



Definition.—VISION is the faculty by which we perceive the form and outline of things.

ORGANS.—The *Eyes* are only the instruments of seeing. They receive the impressions which, by the optic nerves, are conveyed to the perceptive center—the optic lobes of the brain—where the true seat of vision lies.

The *Ball* or *Globe of the Eye* is situated in the cavity of the orbit, resting upon a cushion of fat.

The *Orbit* is pyramidal in shape, the apex directed inward, the base directed outward, and corresponding to the free margin. It is about one and four-fifths inches deep. At its posterior and inner part is the optic foramen, through which pass the optic nerve and ophthalmic artery.

Dimensions of the Eyeball.—Antero-posterior diameter, about one inch; transverse diameter, about eleven lines or eleven-twelfths of an inch.

At the central part of the cornea is situated the *anterior pole;* directly opposite, and at the back part of the eyeball, is the *posterior pole.* A line passing from one pole to the other is the *axis* of the eye. The *equator* of the eye passes vertically through the central portion, and divides the eye into the anterior and posterior hemispheres.

Coats or Tunics.—The external covering of the eye consists of the *sclerotic* and *cornea.* The sclerotic is composed of white fibrous tissue; it is dense, firm, unyielding, and thicker behind than in front. It occupies the posterior five-sixths of the globe of the eye, and serves to maintain its globular shape.

Color.—Externally, the sclerotic is smooth and white; internally, it is stained brown, and grooved by the ciliary nerves. The sclerotic is pierced at its posterior part, and a little to the nasal side, by the optic nerve; its anterior part is connected to the cornea, and is in intimate relation to the conjunctiva. This coat is sparingly supplied with nerves and blood.

The *Cornea* occupies the anterior *fifth* of the eyeball. It is clear, transparent, firm, and resisting. It is *convex* in front and *concave* behind. Blood-vessels do not pass into the cornea, but form loops in the most peripheral portion. On account of the transparency of the nerves, they are found all over the cornea, and thus render it very sensitive, so that a slight scratch on it will cause great pain.

The *Choroid*, together with the ciliary processes, form the second coat of the eye. It occupies the posterior five-sixths of the eyeball, and is distinguished from the other coats by its dark color. It is very vascular, and is perforated posteriorly by the optic nerve. In this coat are found a number of irregular *cells*, containing a *pigment* varying from a brown to a jet-black color. This gives to this coat its characteristic *dark brown* or *chocolate color*. The pigment is darker and more abundant in the negroes and colored races than in blonde persons. It is almost entirely wanting in the albinos. The choroid coat makes a dark chamber of the eye, and absorbs the unnecessary rays of light, thus aiding in perfect vision.

The *Iris* has received its name from the varied color it presents in different individuals. It is a membranous, circular-shaped, contractile curtain, suspended in the aqueous humor of the eye, and divides the portion in front of the crystalline lens into two parts,—the one is called the *anterior chamber*, and is in front of the iris; the other, the *posterior chamber*, and is behind the iris. The aqueous humor passes readily from one chamber to the other.

Color.—The anterior surface is variously colored in different individuals; the posterior surface is a deep purple, and covered with pigmentary cells.

The *diameter of the iris* is about half an inch; its perforation in the center, the *pupil*, is from one-eighth to one-sixth of an inch in diameter.

The *function of the iris* is to regulate the amount of light that enters the eye during the act of vision, and to shut off

the rays of light going through the periphery of the lens. The amount of light entering the eye, and the sensitiveness of the retina, causes the pupil to dilate or contract. This action is plainly seen by placing the hand over the eye and shutting out the light, then suddenly admitting it again, when the mobility of the iris is plainly discernible. The iris differs in color according to the quantity of pigment it contains. If the pigment accumulates in spots, it gives to the iris a dotted appearance. In albinos it is entirely wanting. The iris is plentifully supplied with blood-vessels.

Ciliary Processes.—Formed by the plaiting or folding inward of the middle and internal layer of the anterior portion of the choroid. They form a regular circle of *plaits* or *folds*, usually about seventy in number, and are of two kinds,—*large* and *small*. The large are about one-tenth of an inch in length, and constitute about two-thirds of the entire number. Between the larger folds are found the smaller kind, which make up the remaining one-third.

The *Ciliary Muscle* is the muscle of accommodation or tensor of the choroid. It is about one-eighth of an inch in width, and surrounds the anterior margin and outer surface of the choroid.

The *Retina* is the third coat of the eye, and is a delicate, nervous membrane. It is clear and transparent in life, but becomes opaque and wrinkled after death. Upon this coat the objects of vision are made, and a little to the outer or temporal side of the optic disc is the seat of the most acute vision, called the *fovea centralis*. The retina is very sensitive to light, and, if pressed upon, the sensation of flashes of light is produced.

The *Optic Nerve* penetrates the retina a little within and below the antero-posterior axis of the globe.

The *Hyaloid Membrane* is extremely delicate and transparent, enveloping the vitreous humor of the eye. In front it is continuous with the suspensory ligament of the lens.

The *Capsule of the Lens* is a thin, transparent sac, containing the crystalline lens.

Refracting Media or Humors.—The *Crystalline Lens* is situated immediately behind the pupil, in front of the vitreous body. It is transparent, exceedingly elastic, colorless, and firm in texture. In shape it is *double-convex*, the greater convexity being on its posterior surface.

Dimensions.—Antero-posterior diameter, about one-fourth of an inch; transverse diameter, one-third of an inch.

The lens is composed of layers of fibers which form the outer or delicate softer portion, and, later in life, the nucleus, which becomes apparent at about the fortieth year.

The *function of the lens* is to bring the rays of light passing through it to a focus upon the retina, thus producing distinct perception of form and outline.

Surrounding the border of the lens is the *Canal of Petit*, formed by the separation of the two layers of the suspensory ligament. This canal is triangular in form, and is about one tenth of an inch wide.

The *Aqueous Humor* is situated in the aqueous chamber of the eye, which is bounded in front by the cornea, and posteriorly by the crystalline lens and its capsule. This fluid is clear, perfectly colorless, with a specific gravity of about 1005, and is chiefly composed of water. It is a secretion of the membranes surrounding the anterior and posterior chambers of the eye, and if, from any cause, it escapes from its cavity, it is speedily reproduced. Its removal renders the eye sensitive to light, and obstructs perfect vision. If, during this period, it receives proper treatment, normal vision is again restored.

The *Vitreous Humor* occupies the posterior two-thirds of the globe, and is a clear, transparent, gelatinous substance, being enveloped by the hyaloid membrane, which presents a cup-shaped depression in front to receive the lens. The

specific gravity of this humor is about 1005. It is not supplied with blood-vessels and nerves, but receives its nutrition from the ciliary body and retina. This humor is not affected by heat or alcohol. The acetate of lead will cause it to coagulate.

Adjusting Machinery.—The *Levator Palpebræ Muscle* arises in front of the optic foramen, and is inserted by a broad expansion into the upper eyelid. It is thin, flat, triangular in shape, and at its origin is narrow and tendinous, becoming broad and fleshy as it passes forward. This muscle, when it contracts, raises the upper eyelid.

The *Superior Rectus* arises from the upper margin of the optic foramen, and is inserted in the sclerotic coat at its upper surface, about three-quarters of an inch from the margin of the cornea. The action of this muscle, when contracting alone, is to turn the eye upward.

The *Inferior*, *Internal*, and *External Recti Muscles* arise from round the circumference of the optic foramen, and are inserted in the sclerotic coat in a manner similar to the superior rectus. These muscles, acting singly, turn the eye either downward, inward, or outward, as their names imply.

The *Superior Oblique Muscle* arises just above the inner margin of the optic foramen, and passes forward to the inner angle of the orbit; here it terminates in a rounded tendon, which passes through a ring or pulley, formed by fibro-cartilaginous tissue attached to a depression in the bone at the upper and inner portion of the orbital cavity. The tendon then passes backward and outward, under the superior rectus, and is inserted into the sclerotic coat, midway between the margin of the cornea and entrance of the optic nerve, and between the superior and external recti.

The *Inferior Oblique Muscle* is situated near the anterior margin of the orbit. It arises from the inner corner of the eye, external to the lachrymal groove. From this origin it

passes outward and backward, beneath the inferior rectus, and between the eyeball and the external rectus, and is inserted in the sclerotic coat between the superior and external rectus. The action of the oblique muscles is to rotate the eyeball on its antero-posterior axis.

Protecting Organs.—The *Orbital Arch* surrounds the cavity of the orbit, forming its upper and lower boundary, and affords considerable protection to the eye, owing to the sharpness and prominence of the bone.

The *Eyebrows* are situated upon the superciliary ridge which forms the upper border of the orbit. These short, stiff hairs serve to shade the eye from excessive light, and prevent the perspiration from running from the forehead upon the lids.

The *Eyelids*, two in number, are covered by integument, which is here very thin, and are lined by the conjunctiva. The lids are of the greatest importance in the protection of the eyeball. When the upper and lower lids approximate, they close the orbit, preventing any sudden blow or force from injuring the eyeball.

At the borders of the lids are the *Eyelashes* or *Cilia*—short, stiff, curved hairs. These are arranged in two or more rows, and are curved from the eyeball. They protect the surface of the conjunctiva from dust and other foreign matter.

The *Palpebral Fissures* are the openings between the free margins of the lids. The upper lid is larger than the lower.

Between the skin and the mucous membrane of the eyelids are found the *Tarsal Cartilages*, of dense, hard, fibrous tissue. They are small and elongated, and extend from the edges of the lids toward the margin of the orbit. The one in the upper lid is semi-lunar in form, with its convexity upward. These cartilages serve to give the lids their proper shape. Along the free edge of the upper lid, near its inner margin, may be seen a row of fine dot-like openings, which are the excretory ducts of the Meibomian glands. They secrete an

oily fluid, which smears the edges of the lids and prevents the overflow of the tears.

The *Conjunctiva* is a mucous membrane, lining both the upper and lower lids, and covering the anterior portion of the eyeball. At the inner circumference of the lids this membrane is reflected forward to the eyelids, forming a fold of transmission. The conjunctiva is well supplied with blood-vessels, very sensitive and easily irritated, especially near the free margin of the lid, where the nerves terminate in great abundance.

The *Glands of the Conjunctiva* are numerous, and their secretion serves to moisten the eye to a greater extent than the tears.

The conjunctiva is continuous with the mucous membrane of the nose, by the lining of the lachrymal canals.

Lachrymal Apparatus.—The *Lachrymal Gland* is situated in a shallow depression in the roof of the orbit at its outer portion. It is ovoid, flattened, and in shape and size resembles a small almond. The secretion of this gland—the *tears*—is a thin, watery fluid, perfectly clear and colorless, of a saltish taste, and is distributed over the globe by the movements of the lids and of the eyeball. The secretion is constant, but may be increased by various circumstances. The excess of this secretion passes toward the inner canthus of the eye, enters the lachrymal sac through the canaliculi and lachrymal duct, and is conveyed into the nose by the nasal duct. During sleep the amount of the secretion is much diminished. The tears pass from the lachrymal gland through seven small ducts to the upper portion of the upper lid, where the ducts open into the conjunctival sac.

The *Puncta Lachrymalia* are the minute orifices opening into the canaliculi.

The *Canaliculi* are little canals, two in number, which convey the tears into the lachrymal sac.

The upper and dilated extremity of the nasal duct is termed the *Lachrymal Sac.* Above, it is rounded in form, and, below, continuous with the nasal duct.

The *Nasal Duct* is about three-fourths of an inch in length, and extends from the lachrymal sac to the inferior meatus of the nose.

Both the lachrymal sac and the nasal duct are lined with a mucuous membrane.

Types of Eyes.—A *Hypermetropic* or *Long-Sighted Eye* is one in which the focal distance of the refracting media is longer than the axis of the eye. Such a condition of the eye is termed *hypermetropia*, and there is no clear vision at any distance except by the exercise of accommodation.

A *Myopic* or *Short-Sighted Eye* is one where the focal distance of the refracting media is less than the axis of the eye. Such a condition is known as *myopia.* The *far point* of the myopic eye is at some finite distance, as two feet or three feet; the *near point* is nearer than in the normal eye.

In the *Emmetropic* or *Normal Eye*, the focal distance of the refracting media, is the same as the visual axis of the eye,—*i. e.*, the globe and the refractive media are in such relation to each other and to the retina that parallel rays of light come to a focus at the seat of direct vision. This point is known as the *macula lutea.* The *far point* of the emmetropic eye is at infinite distance; the *near point* at a distance determined by its power of accommodation.

The normal eye is capable of a great variety and amount of use. Objects can be seen near and far with the same ease, and with equal clearness. But because the eyes can see minute objects distinctly, and without difficulty, is no reason that they should be kept almost constantly looking at small objects. Like any other organ of the body, they may be enfeebled or injured by any kind of exercise, too long continued.

Teachers should not allow their pupils to keep their eyes too continuously fixed upon their books. Too close application of the eyes is liable to produce lasting injury to the refractive powers. Pupils should be taught to *think*, as well as remember, and instead of having them

spend all their time in school, and often out of school, and frequently by artificial light, in acquiring a parrot-like faculty of repeating lessons which they do not comprehend, show them how to study and how to fix in the mind the useful portions of the lesson.

Serious harm may be done the eyes by looking at bright objects, as the sun, or any brilliant or glaring light. Looking at small objects during twilight, attempting to read, write, etc., may result in injury to the eyes.

No requisite is of more importance for the use of the eyes, than a *favorable* and *sufficient light*. School-rooms should not be so arranged that a flood of light will fall on the faces of the pupils whose eyes have no protection against the dazzling brightness. The light should be allowed to fall over the shoulder, upon the book or paper, while reading or writing, especially in the evening, when artificial light is used. More harm is done by too little than by too much light. Light, to be agreeable to the eyes, should be soft, steady, and abundant.

CHAPTER XIV.

EAR.

- **Ear**
  - **External**
    - **Pinna or Auricle**
      - **Parts**
        - Helix.
        - Anti-Helix.
        - Tragus.
        - Anti-Tragus.
        - Concha.
        - Lobe.
      - **Muscles**
        - Attollens Aurem.
        - Attrahens Aurem.
        - Retrahens Aurem.
      - Blood Vessels.
      - Function.
    - Meatus Auditorius Externus.
  - **Middle or Tympanum**
    - Membrana Tympani.
    - Cavity or Drum.
    - Openings.
    - **Ossicles**
      - Malleus.
      - Incus.
      - Stapes.
    - **Communications**
      - With the Pharynx.
      - With the Mastoid Cells.
    - Lining Membrane.
  - **Internal or Labrynth**
    - Vestibule.
    - Semi-circular Canals.
    - Cochlea.
    - Auditory Nerve.

The *Pinna*, or *Auricle of the Ear*, is that portion projecting from the head. In shape it is something like a funnel. It is made up largely of flexible fibro-cartilage, which is known as yellow or reticular, and is termed *permanent cartilage*. The cartilage is covered by *perichondrium*.

The outer edge or ridge of the pinna is called the *helix*.

This ridge is more or less distinct in different individuals and varies somewhat in breadth.

The groove just beneath the helix is called the *fossa of the helix*, and the *anti-helix* is the prominent ridge just in front of this fossa.

The *Tragus* is the thickened triangular projection of cartilage just in front of the opening into the auditory canal.

A similar eminence, the *anti-tragus*, is situated just opposite, across the opening of the external meatus.

The *Concha* is the deep fossa immediately surrounding the opening of the meatus.

The fleshy projection or tip of the pinna is called the *Lobe*. This portion it not very sensitive, because sparingly supplied with blood and nerves.

The *Muscles of the Ear*, in man, are usually rudimentary, and of little importance.

The *Blood-Vessels of the Pinna* come from the external carotid. They are the posterior and the anterior auricular, and the auricular branch of the occipital.

The *External Auditory Canal* extends from the concha to the membrana tympani.

Length, about an inch and a quarter.

This canal is lined with integument, which is a continuation of that covering the external ear. In the inner portion of the canal are found the coiled tubes, known as *ceruminous glands*.

The *Cerumen* or *Ear-Wax* is the secretion of these glands. It is of a smeary consistency, yellowish in color, and exceedingly bitter in taste. Its *function* is to lubricate the external meatus, and, on account of its bitter taste, prevents the ready admission of insects. Sometimes the cerumen becomes hardened, and is impacted upon the external surface of the membrana tympani. This inspissated cerumen will often cause sudden impairment of hearing, dizziness, a ringing

noise, and severe pain in the ears. The removal of it should at once receive attention. Tepid water and a syringe, in the hands of a careful and skillful operator, will usually effect its removal. But as the hardening of the ear-wax is rarely an independent affection, it is by no means a simple and harmless disease.

It sometimes happens that foreign bodies become lodged in the external auditory tube, and the forcible and fruitless attempts of the inexperienced to remove them only ends in disaster to the delicate membrana tympani, or in serious inflammatory conditions. Improper attempts of the unskillful or indiscreet, to remove a foreign body from the ear, have often cost the life of the patient. When we remember, that, even where a careful examination is made, a correct diagnosis is sometimes impossible, the importance of consulting a competent physician, before the ear has been meddled with, becomes apparent. By the use of the speculum and otoscope, combined with experience and skill, unpleasant results, both to patient and operator, may be avoided, and the fame of surgical science remain unblemished.

The middle ear presents a narrow, bony cavity, irregular in shape, lined with a mucous membrane, and situated in the substance of the temporal bone. It is separated from the external ear by the *membrana tympani*, or drum-head. In the adult, this membrane does not lie in a horizontal direction, but the upper and posterior borders are about six-twenty-fifths of an inch nearer to the entrance of the external auditory canal than the anterior and lower. This membrane is about as thick as fine letter-paper, and to its inner surface is attached the long process, or head of the malleus.

Cavity or Drum of the Ear.—This is the space lying between the membrana tympani and internal ear. Into this space air is admitted through the Eustachian tube, which communicates with the cavity at the upper part of the anterior wall.

At the upper part of the posterior wall are found the openings of the *Mastoid Cells*, which also contain air, and

are found in the mastoid portion of the temporal bone. These cells are lined with a mucous membrane, which is continuous with the lining of the tympanum. The membrana tympani forms the greater portion of the outer wall of the middle ear. The boundary between the labyrinth and the middle ear forms its inner walls. In this are two small aperatures, which are closed by membranes.

The *Ossicles of the Ear* are the *malleus* or *hammer*, the *incus* or *anvil*, and the *stapes* or *stirrup*. The *malleus* is attached by its handle or manubrium to the membrana tympani, and the long process is attached to the Glaserian fissure of the temporal bone. It articulates with the incus. The *incus* articulates with the malleus and the stapes. The *stapes* is the most internal bone of the ear, and articulates with the incus by the head of the bone. This part of the bone is what some authors call the orbicular or round bone. The stapes is the smallest bone of the ear, and indeed of the entire body. These bones form a chain, stretching from the membrana tympani to the *fenestra ovalis*, where the base or foot of the stirrup is applied. The bones of the ear conduct the sonorous vibrations through the tympanum to the labyrinth.

The tympanum communicates with the pharynx through the *Eustachian Tube*. This tube is about one and two-fifths inches in length, and from its tympanic end runs forward, inward, and downward. It is lined by a mucous membrane, continuous with that lining the pharynx. This lining is covered by ciliated epithelium, the motion of which is toward the pharynx.

The *functions of the Eustachian tube* are to admit air into the cavity of the tympanum and to conduct away the secretions of its lining membrane.

The internal ear is called the *Labyrinth*, on account of it winding passages and complex structure. Its bony cavities are formed by the petrous bone, and in these cavities is contained a membranous portion, separated from the bony part by a clear fluid.

The *Vestibule* is the central, irregular cavity of the bony portion, and is the essential part of the internal ear. The *diameter* of the vestibule, from above downward, as also from behind forward, is about one-fifth of an inch. Its inner wall is perforated for the passage of a portion of the filaments of the auditory nerve. Here also is found the opening of the *aqueductus vestibuli.* At the posterior portion of the vestibule are the five openings of the semicircular canals, and in the anterior wall is a large oval aperature—the opening of the cochlea.

The *Fenestra Ovalis* is in the outer wall of the vestibule and is closed by a delicate membrane.

The *Semicircular Canals* are C-shaped, and start at the vestibule and return to it again, thus forming a semicircle. These canals are three in number, of unequal size, and compressed from side to side. One lies in a horizontal position with its convexity in a lateral direction; the other two have a vertical position, at right angles to each other. The verticle canals have one common opening into the vestibule.

The *functions of the semicircular canals*, according to ancient physiologists, are to preserve the equilibrium of the head, and consequently of the body. By some physiologists they are not considered essential to the sense of hearing.

The *Cochlea* is a bony canal, and so named from its resemblance to a common snail. It forms two and a half turns round an axis or central pillar. Of its *function* little is known; but, according to recent investigations, one is to discriminate between sounds.

By the lining membrane of the parts of the internal ear is secreted a clear fluid known as *Perilymph.* In this fluid is contained the membranous labyrinth, which is a closed sac, containing a fluid called the *Endolymph.* The terminal fibers of the auditory nerve are freely distributed to the membranous labyrinth.

The *Auditory Nerve.**—This is the special nerve of the

* For origin, see table of Cranial Nerves, page 70.

sense of hearing, and is distributed exclusively to the internal ear. From its origin it enters the meatus auditorious internus, in company with the facial nerve. They run together to the bottom of the internal auditory canal, where the facial nerve enters the Fallopian canal, and the auditory nerve divides into two branches, which are distributed to the cochlea, vestibule, and semicircular canals; hence called *cochlear* and *vestibular branches.*

The pinna of the ear collects the waves of sound, and through the external meatus conveys them to the membrana tympani, which causes it to vibrate. These vibrations are conducted by the chain of bones to the liquid of the labyrinth, and by it to the terminal filaments of the auditory nerve. By the auditory nerve the vibrations are conveyed to the brain, the seat of the sense of hearing.

CHAPTER XV.

OLFACTION.

The *Nasal Fossæ* are situated in the middle of the face, extending backward from the nose to the pharynx. They are two irregular-shaped cavities, with a lining membrane called (from Schneider, its describer) the *Schneiderian mucous membrane.* This lining is continuous with that of the pharynx, the nasal duct, the Eustachian tube, the frontal and ethmoid sinuses, and the antrum of Highmore. These cavities all communicate with the nasal fossæ. The only part of this membrane capable of receiving odorous impressions is that lining the upper half of the nasal fossæ. This is the part receiving the terminal filaments of the olfactory nerves. [By reference to the table of Cranial Nerves, page 70, the principal part of the history of these nerves may be obtained.]

Upon the cribriform plate of the ethmoid bone, by the

side of the crista galli, the olfactory nerve expands into an oblong mass of grayish-white substance, called the *olfactory bulb.* From the under surface of this bulb are given off from eighteen to twenty nervous filaments. These filaments pass through the ethmoidal foramina, in the cribriform plate of the ethmoid bone, and are distributed to the mucous membrane of the nose. They endow the membrane of the nasal fossæ with the sense of smell.

The olfactory nerves possess the special sense of smell alone, and are entirely insensible to ordinary impressions. It is well known that, in the dog, the sense of smell is very acute. An experiment is cited by Flint, where, in one of these animals, the olfactory bulbs were divided or extirpated. "After the animal had completely recovered, it was deprived of food for thirty-six or forty-eight hours; then, in its absence, a piece of cooked meat was concealed in a corner of the laboratory. Animals, successfully operated upon, then taken into the laboratory, never found the bait; and, nevertheless, care had been taken to select hunting dogs." Such experiments are absolutely conclusive as regards the endowment of these nerves.

TASTE.

By Taste or Gustation is meant that sense which enables us to appreciate the *quality* or *savor* of any substance introduced into the mouth. The various portions of the mouth,—viz., the tongue, the lips, the inside of the cheeks, the palate, pharynx, etc.,—are all susceptible of impressions by contact with sapid bodies. Nearly all substances affecting these parts possess a certain odor, and the word *savory* often includes the quality of odor; hence *taste* and *odor* are intimately connected. Odoriferous substances are sometimes spoken of as having taste, such as the onion, wines, etc., when, in fact, the odor is only perceived by the olfactory nerves, as they are held in the mouth. This is clearly demonstrated by holding the nose, or when the nasal mem

brane is rendered inert by a catarrh. Two nerves are concerned in the sense of taste—viz., the chorda tympani and glosso-pharyngeal.

The *Chorda Tympani* is a branch of the facial nerve. Numerous pathological cases, in which lesion of this nerve occurred, and also many experiments upon living animals, leave no doubt of its connection with the sense of taste. If a section of the chorda tympani be made, the sense of taste is abolished in the anterior two-thirds of the tongue. Certain it is, that, in the human subject, the gustatory properties of this portion of the tongue depend upon this nerve.

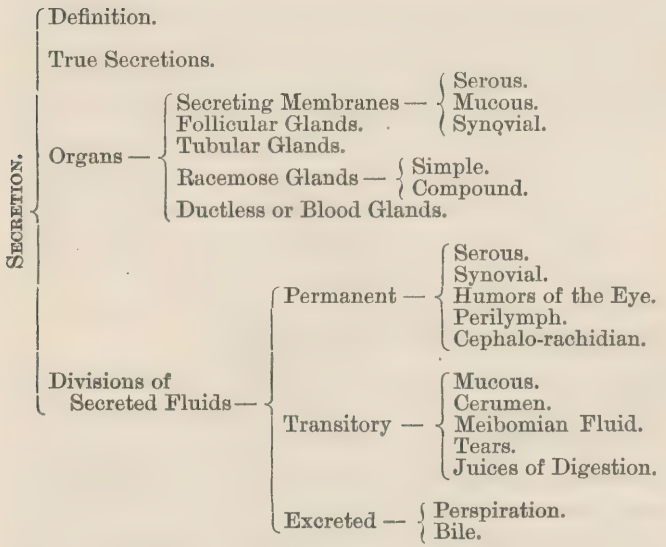
The *Glosso-Pharyngeal Nerve* is the first of the eighth pair cranial nerves. Its origin, in common with that of the pneumogastric, is from the medulla oblongata, and it passes out from the cranium through the jugular foramen. It has an extensive distribution, sending out branches to the pneumogastric, which are connected with the sympathetic by branches which go to the carotid plexus. It is also connected with the labyrinth and tympanum of the ear by its tympanic branch, and when it reaches the base of the tongue supplies the mucous membrane covering the tonsils and soft palate, while the lingual branches penetrate the tongue, and are distributed to the mucous membrane at its base. This nerve endows the posterior portion of the tongue with the sense of taste, and is also an ordinary sensory nerve.

In man, the dorsal surface of the tongue is the principal organ of taste. This surface is covered with a mucous membrane, beset with vascular and nervous papillæ. The sense of taste gives us impressions of only those substances which come actually in contact with sensitive surfaces, and does not establish communications with objects at a distance. The surfaces possessing the sense of taste are also endowed with general sensibility. In order that taste may be perceived, the sapid substance, when brought in contact with the mucous membrane of the mouth, must be *in a state of solution.* The sapid substance may possess a marked savor, yet, if in a solid state, it produces no other impression than that of

any foreign body which may come in contact with the sensitive surfaces. The liquid and soluble portions of our food, such as animal and vegetable juices and the soluble salts, alone possess the quality of taste. When sapid substances are in solution, they penetrate the papillæ of the tongue by endosmosis, and come in actual contact with the terminal filaments of the nerves, thereby exciting their sensibility.

CHAPTER XVI.

SECRETION AND EXCRETION.



Definition.—Secretion is a natural function of the body by which various fluids or substances are separated from the blood, differing in different organs according to their peculiar function.

When the fluids of the secretion are produced by special

organs, and have important functions to perform, but are not discharged from the organism, they are known as *true secretions.* All the digestive fluids are examples of this class. Such fluids as are composed of water, holding in solution one or more characteristic principles, resulting from the physiological waste of the tissues, and having no function to perform in the animal economy, may be classed as excretions.

The secretion of the kidneys is a type of these fluids.

The *Bile* would seem to belong to both of these divisions, as it performs important functions as a secretion, and also contains certain excrementitious matters, which are discharged from the organism.

Organs.— *Secreting Membranes.*— The serous membranes are the *arachnoid*, *pleuræ*, *pericardium*, and *peritoneum.* They have a smooth, glossy surface, and line cavities which have no external communication. As a rule, they are in the form of shut sacs. From their inner surface is exuded a transparent *serous* fluid, from which they take their name. This fluid is usually small in quantity, and is contained in the cavities of the membranes. We have an exception to this rule in the arachnoid membrane, where the fluid is found beneath both layers.

The *Mucous Membranes* line cavities or tubes communicating with the exterior by the different openings of the body. The membrane lining the mouth, the lower part of the pharynx, the œsophagus, and the conjunctiva provided with *pavement epithelium.* A second variety, found in the alimentary canal below the cardiac orifice of the stomach, the biliary passages, the excretory ducts of all the glands, the nasal passages, the upper part of the pharynx, the bronchi, and the Eustachian tubes is known as *columnar epithelium.* This variety is furnished on its free surface with little hair-like cilia, which are in constant motion during life. This membrane everywhere secretes a smooth, viscid-like fluid, generally grayish and semi-transparent, and termed *mucus.* This fluid forms a coating for the mucous membranes, pro-

tecting them and enabling their surfaces to move freely upon each other. Some of the mucous glands are continually secreting this fluid, while others, as the follicles of Lieberkuhn, only at particular times.

The *Synovial Membranes* are found in the movable articulations, and in other parts of the body as closed sacs, sheaths, etc. Through these sheaths tendons of muscles pass, and the fluid secreted prevents inflammation and allows the tendons to move freely.

The simple mucous follicles and the follicles of Lieberkuhn are examples of the *Follicular Glands.*

The *Tubular Glands* are similar to the follicles, except that the tubes are long and more or less convoluted. The kidneys are examples of these glands.

The *Compound Racemose Glands* are composed of rounded follicles, arranged around the extremities of branching ducts, like bunches of grapes. In the simple gland, but a single excretory duct is found.

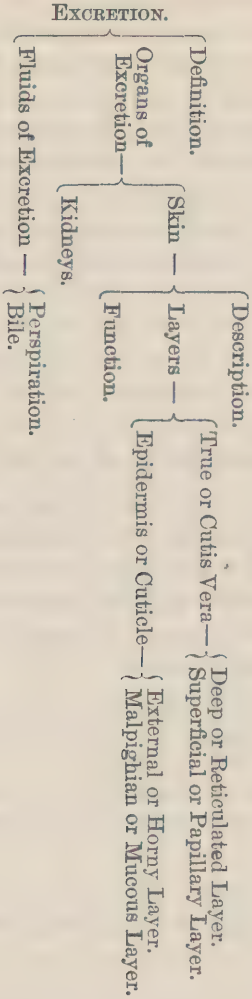
The *Ductless Glands* are such as contain blood-vessels, lymphatics, nerves, and a peculiar pulpy structure. They are supposed to modify the blood as it passes through their substance, and hence are call blood glands. The spleen and thyroid gland are examples of this character of glands.

The *Permanent Secretions* are such as have a more or less mechanical function. [See outline.]

Reference has been made to the *transitory fluids* under their appropriate headings.

The general surface of the body is constantly lubricated by a small quantity of oily secretion or sebaceous matter. In all parts of the body provided with hair are to be found the true sebaceous glands. They are not found in the palms of the hands nor in the soles of the feet. These glands present a number of ducts, with their follicles, opening by a common tube. This sebaceous matter is more abundant in some parts of the cutaneous surface than in others. The object of this

secretion is to lubricate the general surface of the body and give to the hairs that softness which they possess when in a healthy condition.



The act of throwing off effete matter from the animal system, or of separating from the blood those fluids which are supposed to be useless, is known as Excretion.

The *Skin* is the external membranous envelope of animal bodies. It is the principal seat of touch, forming a protective covering for the deeper tissue of the body. It is an excretory and absorbing organ, and one of the most complex and important structures of the body. Over the parts of the body where pressure or friction is found, the skin is quite thick, and where the parts are movable, or liable to increase in size, it is elastic. In many situations it is covered with hair, which serves as an additional protection to the subjacent structures. In a man of ordinary size the cutaneous surface amounts to sixteen or seventeen square feet. In a woman of medium size this surface equals about thirteen feet. The thickness of the skin is from one-twelfth to one-eighth of an inch. In the soles of the feet or palms of the hands, where it is exposed to constant pressure and friction, it becomes very much thickened; but in certain parts, as the external auditory meatus and the lips, it is frequently not more than one-one-hundredth of an inch.

The *True Skin*, or *Corium*, is the inner layer of the skin proper, and is divided into two portions,—the *deep* or *reticulated* and *superficial* or *papillary layer*. The reticulated layer is much thicker than the papillary layer; it is dense, resisting, elastic, slightly contractile, and composed of bundles of white fibrous tissue.

The papillæ of the papillary layer are abundantly supplied with blood-vessels.

The *Epidermis*, or *External Layer of the Skin*, does not contain blood-vessels, nerves, and lymphatics, but is composed exclusively of cells.

The external part of the epidermis is called the *horny layer*, and is composed of numerous strata of hard, flattened cells.

The *Malpighian Layer* is composed of nucleated cells, containing a certain amount of pigmentary matter called the *melanine*. The characteristic color, and the peculiarities in the complexion of different races and of different individuals

is due chiefly to the pigmentary layer. The more delicate structures of the true skin are protected by the epidermis.

The skin is everywhere provided with numerous and important glands, known as *sudoriparous glands*, which secrete the sweat. These glands consist of a simple arrangements, presenting a coiled mass beneath the skin, and a tube of greater or less length, which is the excretory duct. The coiled mass is the sudoriparous portion, while the tube simply conducts the sweat to the surface of the body.

The nervous system has a remarkable influence over the secretion of the perspiration. Mental emotions will frequently cause an abundant production of perspiration. The daily quantity of perspiration is about two pounds. During exercise, or whenever there is a tendency to elevation of the animal temperature, the blood comes toward the surface, accompanied with an increase in the secretion of the sweat. If the body is exposed to a high temperature, as working before a furnace, the perspiration is enormously increased, and it is only on account of the rapid evaporation upon the surface of the skin that persons can endure such extreme intensity of heat. A great many effete matters are carried off by perspiration, and it is now known that urea is a constant constituent of the sweat. A sudden check or stoppage of the perspiration, when it is in a perfect normal condition, is deleterious to life. But if the perspiration be enormously increased, caused by external heat, a sudden stoppage does not result disastrously to the animal economy.

KIDNEYS.

The kidneys are situated in the back part of the abdominal cavity, behind the peritoneum, one on each side of the vertebral column, in the lumbar region. The one on the right side is a little lower than the one on the left. They are symmetrical organs, surrounded by more or less adipose tissue, and are held in their position by the blood-vessels.

They are bean-shaped, with the concavity looking inward toward the spinal column. The deep central portion of this concavity is called the *hilum.*

The *weight of the kidney* is from four to six ounces in the male, and from four to five and a half ounces in the female. The left kidney is usually a little heavier than the right.

They are about four inches long, two inches wide, and one inch in thickness.

The kidney consists of two different substances; that which occupies the surface is known as the *cortical substance;* that situated internally, as the *medullary substance.* Outside of these two substances is a thin, smooth, and close net-work of white fibrous tissue, containing also some elastic fibers; this, the *proper coat* of the kidney, is continued inward at the hilum, in the form of a smooth membrane, forming little cylinders, or calices.

The *Cortical Substance* is about one-sixth of an inch in thickness, occupies the surface and forms about three-fourths of the gland. It is soft, reddish, granular, and less resisting than the pyramidal substance.

The *Medullary Substance* is darker and denser in structure than the cortical substance, and is made up of reddish-colored, conical masses, called the *pyramids of Malpighi.* They are from eighteen to twenty in number, with their bases directed toward the circumference of the organ, and their apices received in the little cylinders formed by the continuation of the proper coat of the kidney through the hilum.

Blood-Vessels of the Kidney.—The *Renal Arteries* are given off from the abdominal aorta, one on either side, and directed outward at almost right angles to it. As they enter the hilum of the kidney, they divide into four or five branches, and then, by numerous smaller branches, penetrate the substance of the kidney between the pyramids and ramify in the columns of cortical substance which occupy the spaces between the pyramids.

The *Veins of the Kidney* collect the blood from the vessels of the Malpighian bodies, and conduct it inward, where they enter into larger veins, finally emerging at the hilum in a single vein which terminates in the inferior vena cava.

While the blood is passing through the kidneys it undergoes many changes in composition. It loses urea and other matters to be evacuated, found in the secretion of these glands. The blood of the renal veins is said to contain less water than the blood in any other part of the venous system.

GLOSSARY.

GLOSSARY.

ABD

AB-DO'MEN. (To "hide.") The largest cavity in the body; the belly. The same region in the lower animals.

AB-NOR'MAL. Contrary to the natural condition; unnatural; not healthy.

AD'I-POSE. ("Fat.") Pertaining to or consisting of animal fat; fatty.

AL-BU'MEN, AL-BU'MIN-IS. The white of an egg. Found in the animal and vegetable kingdoms. Enters largely into the composition of blood, muscles, etc.

AL-BU'MIN-OUS. Containing or resembling albumen.

AL'I-MENT. That which affords nourishment. [See *Alitura* and *Pabulum.*]

AL-I-TU'RA. (To "nourish.") The process of assimilation or nutritrition; food or nourishment; aliment.

AM-PHI-AR-THRO'SIS. A peculiar mixed articulation, permitting but slight motion.

AN-AS-TO-MO'SIS. The communication of branches of vessels with each other.

A-NAT'O-MY. The science of organization, or the dissection of organized bodies, whether human, brute animal, or vegetable.

AXI

AN'TRUM OF HIGHMORE. A cavity in the superior maxillary bone, described by Highmore.

A-RE'O-LAR. (A "small, open space.") A name given to tissue containing small spaces or interstices.

AR-THRO'DI-A. An articulation admitting of a gliding movement, as in the articulation of the sternum and clavicle.

AS-PHYX'I-A. Apparent death, or suspended animation, particularly from suffocation or drowning, or the inhalation of irrespirable gases.

AT-TOL'LENS AU'REM. ("Raising the ear.") The name of a muscle whose office it is to raise the ear.

AT'TRA-HENS AU'RIS. The name of a muscle whose office it is to draw the ear forward and upward.

AU'RI-CLE, or AU-RIC'U-LA. The external portion of the ear.

AU'TOP-SY. (The "act of seeing.") Ocular examination, or personal inspection.

AX-IL'LA. The armpit; the cavity under the upper part of the arm and shoulder.

B.

BIP

BI-PEN'NI-FORM. Radiating from both sides, like the barbs of a feather.

BUC'CAL. ("Cheek.") Belonging to the cheek.

CRE

BUC-CI-NA'TOR. Name given to a flat muscle which forms the wall of the cheek; so called from its use in blowing a trumpet.

C.

CAN'CEL-LOUS. Pertaining to the lattice-work or cellular structure in bones.

CAU'DA E-QUI'NA. ("Horse tail.") The termination of the spinal marrow, giving off a large number of nerves, which, when unravelled, resemble a horse's tail.

CAN'THUS; *plural*, CAN'THI. The angle formed by the junction of the eyelids.

CEPH'A-LO-RACH-ID'I-AN, CEPH'-A-LO-SPINAL. Belonging to the head and spine.

CE-RU'MEN. ("Wax.") Ear-wax. The wax-like secretion of the ear, given out by follicles of the inner surface of the meatus auditorious externus.

CHOR'DÆ TEN-DIN'E-Æ. ("Tendinous cords.") Attachments connecting the carneæ columnæ of the ventricles to the auricular valves of the heart.

CIL'I-A; *plural* of CIL'I-UM. The eyelashes, or hairs on the eyelids.

CIR-CUM-DUC'TION. Circular movement of a limb.

COCH'LE-A. (A "snail-shell.") Anything of a spiral form. A conical cavity of the internal ear.

COM'MIS-SURE, or COM-MIS-SU'RA. (To "put together.") A joining together by an angular union of parts.

CON-GES'TION. (To "carry or heap together.") An excessive accumulation of the contents of any of the blood-vessels or ducts.

CONCH'A, konk'a. ("Shell.") Applied in anatomy to the hollow portion of the external ear.

CON-VO-LU'TION. Anything rolled together in an undulating manner.

COR'NE-A. ("A horn.") A transparent, convexo-concave, nearly circular substance, forming the anterior part of the eyeball.

COR'PUS CAL-LO'SUM. The white medullary substance joining the hemispheres of the brain.

COR'O-NAL. (A "crown.") The name of a suture uniting the frontal with the parietal bones.

COR'NU. ("Horn.") Applied to a certain kind of warts on account their horny hardness.

CREP'I-TANT. Crackling or rattling. The noise produced by grating the ends of a fractured bone together, or by pressing between the fingers any portion

of cellular tissue in which air is collected.

CRIS'TA GAL'LI. ("Cock's crest.") The peculiar process on the ethmoid bone to which the falx cerebri is attached.

CU-TA'NE-OUS. (The "skin.") Belonging to the skin.

D.

DEG-LU-TI'TION. ("To swallow down.") The act of swallowing.

DES-IC-CA'TION. The act of drying.

DI-AG-NO'SIS. (To "discern.") The science of signs, or symptoms, by which one disease is distinguished from another.

DI-AR-THRO'SIS; *pl.*, DI-AR-THRO'SES. An articulation, permitting the bones to move freely on each other in every direction, like the shoulder and hip.

DI-E-TET'IC. (To "feed.") Belonging to the taking of proper food, or to diet.

E.

EM'I-NENCE. An elevation.

EN-AR-THRO'SIS. The ball and sockt joint; a variety of the class Diarthrosis.

EP-I-THE'LI-UM. The cuticle covering the lips, fauces, and the mucous membranes.

E-RUC-TA'TION. ("To belch.") Belching; escape of wind from the stomach.

ETH'MOID. Resembling a sieve; cribriform.

EX-CRE-MEN-TI'TIOUS. Relating to the alvine fæces, or waste matter discharged from the bowels.

F.

FAL'CI-FORM. (A "scythe" or a "sickle.") Resembling a scythe in shape.

FALX CER'E-BRI. The falciform process between the hemispheres of the brain.

FAS-CIC'U-LUS; *pl.*, FAS-CIC'U-LI. (A "bundle.") Applied to a bundle of muscular or nervous fibers, etc.

FAU'CES. The cavity at the back of the mouth from which the pharynx and larynx proceed.

FER-MEN-TA'TION. (To "leaven.") The spontaneous changes which aqueous combinations of animal and vegetable matter undergo when exposed to the air at an ordinary temperature.

FI-BRIL'LA. (A "fiber.") Applied to the extremely slender filaments seen by the microscope.

FI'BRO-CAR'TI-LAGE. Membraniform cartilage. The substance, intermediate between proper cartilage and ligament, consti-

tuting the base of the ear, determining the form of that part; and composing the rings of the trachea, epiglottis, etc.

FLEX'I-BLE. Capable of being bent, bowed, or twisted without breaking.

FOS'SA. A groove, shallow cavity, or depression.

FO'VE-A CEN-TRA'LIS. A pit or depression upon the retina, a little to the outer or temporal side of the optic disc, and the seat of the most acute vision.

FUNC'TION. (To "fulfill an office.") Any action by which vital phenomena are produced.

FU-NIC'U-LUS. A little cord; the central thread-like part, or axis-cylinder of a nerve.

FU'SI-FORM. (A "spindle.") Resembling a spindle; tapering.

G.

GAS-SE'RI-AN GAN'GLI-ON. The semilunar ganglion. A ganglion of the fifth pair of nerves, first discovered by Gasser.

GE'NI-O-HY-O-GLOS'SUS. The name of a muscle arising from the chin, and inserted into the hyoid bone and whole length of the under surface of the tongue.

GIN'GLY-MUS. A hinge-like articulation, in which the bones move upon each other in two directions only, viz., forward and backward, as in the elbow and knee.

GLAND. An organ of secretion, consisting of blood-vessels, absorbents, and nerves, for secreting or separating some particular fluid from the blood.

GOM-PHO'SIS. (To "drive in a nail.") A variety of the synarthrodial joints, in which one bone is fixed in another like a nail in wood, as the teeth in their sockets.

H.

HÆM-A-GLO'BINE. The coloring matter of the blood.

HE'LIX. (To "wind about.") The outer portion of the external ear.

HEP-A-TI-ZA'TION. ("Liver.") A change of structure in the lungs, or other texture, into liver-like substance.

HO-MO-GE'NE-OUS. Of the same kind or quality throughout.

HY-O-GLOS'SUS. A large muscle of the neck, connecting the os hyoides with the tongue.

I.

IM-BI-BI'TION. The act of drinking in or sucking up moisture.

IM-MO-BIL'I-TY. The condition or quality of being immobile; fixedness in place or state, as a stiff joint.

IM-PEN'E-TRA-BLE. Not capable of being penetrated or pierced; not

admitting the passage of other bodies.

IM-PACT'ED. To drive close; to press or drive firmly together.

IN-GES'TA. Applied to the aliment taken into the body by the mouth.

IN-OS'CU-LAT-ING. Opening into each other; anastomosing, as the tubes of some plants.

IN-SOL'U-BLE. Not soluble; incapable of being dissolved, particularly by liquids.

IN'SPIS-SAT-ED. Made thick by the evaporation of the thinner parts. Applied to vegetable juices.

IN-TER-MIT'TENT. Applied to a disease which disappears and returns again and again at regular or uncertain intervals.

L.

LA'BI-AL. Belonging to the labium, or lip.

LACH'RY-MAL. Structures concerned in the secretion and transmission of the tears.

LAMB'DOID, or LAMB-DOID'AL. A name given to a suture uniting the occipital bone to the two parietal bones; so called because of its resemblance to the Greek letter lambda (Λ).

LA-MEL'LA. A thin plate or scale of anything.

LEG'UME. A pericarp of two oblong valves, in which the seeds are arranged along one suture only.

LE-GU'MI-NOUS. Having legumes.

LEUC'O-CYTE. (A "cell resemblance.") Cell-like. A term applied to corpuscles, as those of the lymph, chyle, pus, blood, etc., which seem to resemble each other essentially in their chemical and microscopical characters.

LIG-A-MEN'TA SUB-FLA'VA. The ligaments occupying the intervals between the vertebræ, which thus complete the back part of the spinal canal. They are composed of dense, yellow, elastic fibers.

LIN'GUAL [LIN-GUA'LIS]. A muscle belonging to the under surface of the tongue.

LI'QUOR SAN'GUI-NIS. ("Liquor of the blood.") The colorless fluid which holds the globules of the blood in suspension during life.

LOB'U-LAR. Belonging to a lobule; shaped like a lobe or lobule.

LOB'ULE. A small lobe.

LU-BRI-CA'TION. The act of lubricating; making slippery or smooth.

M.

MAC'U-LA LU'TE-OUS. (*Macula*, a spot upon the skin or elsewhere; *luteous*, yellow.) A deep yellow spot.

MA-NU'BRI-UM. Literally, a "hilt" or "handle." Applied in anatomy to the uppermost part of of the sternum.

MAS

Mas-ti-ca'tion. ("Chew.") The act or process of chewing; also, the taking, chewing, and insalivation of food.

Ma-tu'ri-ty. The state of being mature; ripeness; a state of perfection or completeness.

Max'il-la-ry. Appertaining to the jaw.

Max'i-mum. ("Great.") A term denoting the greatest possible quantity or effect.

Me-a'tus. A passage. An opening leading to a canal, duct, or cavity.

Me-di-a-sti'num. ("Standing in the middle.") The septum or duplicature of the pleura, which divides the cavity of the thorax into two parts; the septum thoracis.

Med'ul-la-ry. ("Marrow.") Belonging to marrow or to pith.

Mei-bo'mi-an Glands. Small glands between the conjunctiva and tarsal cartilages, so called from their discoverer.

OSS

Mem'o-ry. The faculty of the mind by which it retains the knowledge of previous thoughts or events; the actual and distinct retention of past ideas in the mind.

Mes'i-al. ("Middle.") Synonymous with *Median.*

Min'i-mum. ("Least.") A term denoting the least possible quantity or effect.

Mi'tral. (A "turban" or "miter.") Name of the left auriculoventricular valves of the heart.

Mo'tor. ("Motion.") To move; nerves upon which voluntary motion depends.

Mu'cous. ("Mucous, or "gum.") Belonging to, or resembling, mucus.

My'e-line. ("Marrow.") Applied by Virchow to the medullary matter filling the space between the axis-cylinder and sheath of the nerve fibers.

My-op'ic. Belonging or relating to near-sightedness.

N.

Nau'se-a. Sickness of the stomach without vomiting.

Neu'rin, or Neu'rine. The matter of which nerves are composed.

Ni-trog'e-nous. Pertaining to, or containing, nitrogen, or substances capable of being converted into blood, and of forming organic tissues.

O.

Oc-cip'i-tal. Belonging to the occiput. The name of the bone forming the posterior part of the skull.

O-le-ag'i-nous. ("Oil.") Oily; unctuous.

Ol-fac'tion. ("Smell.") The exercise of the sense of smell.

O'pal-ine. Having the milky and bluish tint, with the reflection of light of the opal.

Os'si-cle. ("Bone.") A small bone.

P.

PAB

PAB'U-LUM. [From *pas'co*, to "feed."] Food; aliment; sustenance.

PAL'PE-BRAL. Belonging to the eyes.

PA-REN'CHY-MA. The spongy and cellular tissue that connects parts.

PA-RI'E-TAL. [From *pa'ries*, a "wall."] Belonging to the parietes or walls of any cavity, organ, etc.

PA-THOL'O-GY. The doctrine or consideration of diseases. It treats of diseases, their nature and effect.

PEN'NI-FORM. ("Feather.") Having the form of a feather.

PER-FO-RA'TION. A hole or aperture passing through any thing, or into the interior of a substance.

PER-I-CHON'DRI-UM. ("Cartilage.") A membrane forming the immediate covering of cartilage.

PER'I-LYMPH. ("Around," "water" or "watery fluid.") So named because poured around in the canals of the ear.

PER-I-MYS'I-UM. The delicate membrane immediately covering the muscle.

PER-I-OS'TE-UM. The thin delicate membrane forming the immediate covering of the bones.

PE-RIPH'E-RY. The circumference of a circle, ellipse, or other similar figure.

PER-I-STAL'TIC. Vermicular motion of the bowels.

PYR

PE'TROUS. ("Rock.") Belonging to or resembling a rock or stone.

PIN'NA. (A "wing" or "feather.") The *ala*, or lower cartilage of either side of the nose. Also, the broad portion of the external ear.

PIT-U'I-TA-RY. ("Phlegm.") Belonging to phlegm.

PHE-NOM'E-NON. An appearance; anything remarkable.

PHLEGM. The thick, viscid mucus secreted by the respiratory and digestive passages.

PHO-NA'TION. ("Voice.") The formation of the voice; also the physiology of the voice.

PLA-TYS'MA. ("Broad sheet," and to "dilate.") An expansion, or dilatation.

PLI'ANT. Capable of plying or bending; easily bent; readily yielding to force or pressure without breaking.

PRE-HEN'SION. The act of grasping or taking hold; a seizure.

PSY-CHOL'O-GY. A discourse or treatise on the human soul; the science of the human soul; specifically the systematic or scientific knowledge of the powers and functions of the human soul, so far as they are known by consciousness.

PY-RO'SIS. Water-brash; a disease characterized by pain in the stomach, with copious eructation of a watery, insipid fluid.

R.

RAC

Ra-ceme'. Originally, a "cluster of grapes."

Rac-e-mose'. ("Raceme.") Bearing or resembling racemes.

Ra'di-ate. To emit or send out in direct lines from a point or points; as, to radiate heat or light.

Rea'son. The faculty or capacity of the human mind, by which it is distinguished from the inferior animals.

Re-fract'ing Me'di-um. That which causes a ray of light to

SNE

deviate from its original direction.

Ren'o-vate. To make over again; to restore to freshness; to render as good as new; to renew.

Re-tic'u-lar. ("Net.") Pertaining to or resembling a net.

Ret'ra-hens. Drawing back; retracting.

Ro-ta'tion. (To "turn round.") The act of rotating or turning round.

Ru-di-ment'a-ry. Relating to rudiments, or the rude state or commencement of anything.

S.

Sag'it-tal. Relating to, or shaped like, an arrow. The suture which unites the parietal bones.

Sar-co'lem-ma. (A "covering.") The sheath which surrounds the fibrils of muscles.

Scle-rot'ic. Hard; tough. The hard, dense, fibrous membrane of the eye; sometimes called the white of the eye.

Se-cre'tion. (To "separate," or to "secrete.") A natural function of the body, by which various fluids or substances are separated from the blood.

Sem-i-lu'nar. Resembling a half-moon or crescent.

Sen-sa'tion. (To "perceive," to "think," or to "feel.") The consciousness of an impression made by an external body on the organs of sense.

Sen-so'ri-um. Center of sensation; the brain; also the collection of ganglia at the base of the brain.

Sen-ti'ent, sen'she-ent. (To "perceive," or to "feel.") Having sensation or feeling.

Sep'tum. Applied to bony, cartilaginous, or membranous partitions in the human body.

Sig'moid. Curved like the letter S.

Si'nus. (A "cavity" or "winding.") In surgery, the cavity of a sore; also a long, narrow, hollow track leading from some abscess, diseased bone, or the like.

Sneez'ing. A convulsive action of the respiratory muscles, caused by the irritation of some part of the lining membrane of the nostrils.

SON

So-no'rous. Giving sound when struck; as, metals are sonorous bodies.

Spasm. The sudden, involuntary contraction of muscles, or of muscular fibers; a convulsion, cramp.

Sphe'noid. Resembling a wedge.

Sphinc'ter. (To "bind tight;" to close.) A circular muscle which contracts the aperature to which it is attached.

Squa'mous. Relating to, or resembling, a scale.

Squa'mous Su'ture. The suture which unites the squamous portion of the temporal bone to the parietal.

Stim'u-lus; *pl.*, Stim'u-li. (A "goad," "sting," or "whip.") That which rouses or excites the vital energies, whether of the whole system or of a part.

Sto'ma; *pl.*, Sto'ma-ta. A mouth. Also, a breathing pore; a minute orifice in the epidermis of leaves through which exhalation takes place.

Stri'a; *pl.*, Stri'æ. Signifying a "groove," "furrow," or "crease." Applied in anatomy to longitudinal marks or lines.

TON

Sty'lo Glos'sus. ("Tongue.") A muscle arising from the styloid process and the stylo-maxillary ligament, and inserted into the root of the tongue. It moves the tongue laterally and backward.

Su-do-rif'er-ous. Bearing sweat; serving to carry off sweat.

Sul'cus. A groove, furrow, or trench. Applied in the *plural* (Sul'ci) to grooves on the surface of the brain and other organs.

Su'per. Signifies "above," "upon," "beyond."

Su-per-cil'i-a-ry. Belonging to the supercilium.

Su-per-cil'i-um. [From *supra*, above, and *cilium*, the eyelid.] The eyebrow.

Su-tu'ra. (To "sew together.") A "suture" or "seam." Applied in anatomy to the junction of the bones of the cranium by a serrated line resembling the stitches of a seam.

Syn-ar-thro'sis. To join together. An immovable joint or an articulation without sensible motion.

Syn'chro-nous. Happening at the same time.

T.

Ten-to'ri-um. A tent or pavilion. Applied to the horizontal process of the dura mater between the cerebrum and cerebellum.

Ther-à-peu'tics. That branch of medicine which treats of the application of remedies, and the curative treatment of disease.

Tin-ni'tus. A ringing or tinkling.

Tis'sue. ("That which is woven;" a "web.") The texture or grouping of anatomical elements of which any part of the body is composed.

To-nic'i-ty. ("Belonging to or having tone.") The quality of

TON

muscular fiber in a state of action.

TON'SIL. A small, oval, almond-shaped gland in the recess between the pillars or arches of fauces.

TON-SIL-LI'TIS. Inflammation of the tonsils; a species of sore throat.

TRIT-U-RA'TION. The process of reducing solid bodies to powder by continued rubbing.

VOL

TRA'GUS. [A "goat;" because it is in many persons covered with hair.] A part of the ear.

TRI-CUS'PID. [From *tris*, "three," and *cuspis* a "point."] Having three points.

TUR'BI-NA-TED. Bones. ("Top-shaped bones.") Two bones of the nostrils; so called from their being formed like a top.

U.

UN'DU-LATE. Waved or wavy; fluctuation.

UN'GUIS. The nail of a finger or a toe; also applied to the talons or claws of birds.

UN'GUIS, Os. ("Nail bone.") The name of a small, very thin, and semi-transparent bone at the inner side of the orbit of the eye.

U-RE'A. A principal constituent of the urine. It is a white, transparent, crystallizable solid.

V.

VAS'CU-LAR. Having, or relating to vessels full of vessels.

VEN'TRI-CLE. Applied to certain cavities of the brain or heart.

VER'TEX. The summit or top of anything. In anatomy, the top or crown of the head.

VIS'CUS; *pl.*, VIS-CE'RA. Any large organ contained in the cavity of the body.

VIS'CE-RAL. Belonging to the viscera.

VO-LI'TION. The act of willing, or choosing. The act of forming a purpose.

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TESTIMONIALS.

DAVENPORT, IOWA, July 9, 1881.

I have examined the "Outlines in Anatomy, Physiology, and Hygiene," written by J. C. ARMENTROUT, and have no hesitancy in saying that the book will prove a great step in advance of most of the treatises on the subject for common school purposes,—concise, systematic, and lucid. The "Outlines" ought to lighten the labor of both teacher and pupil, and leave a much more lasting impression of the subject in young minds than is now commonly the case.

W. D. MIDDLETON, M.D.,
Professor of Physiology and Microscopic Anatomy, S. U. I.

MR. J. C. ARMENTROUT — *Dear Sir:* I have examined some of the proof-sheets of your "Outlines in Anatomy, Physiology, and Hygiene," and I want to say that I heartily approve of your plan; that I believe it to be a rational effort to present the essential facts of these sciences concisely, and divested of the useless matter that usually encumbers them; and that, so far as I have seen, your plan is very successfully carried out. Yours very truly,

S. CALVIN,
Professor of Natural Science, S. U. I.

DES MOINES, IOWA, July 6, 1881.

To Whom It May Concern:

I have had the opportunity of examining the general plan and some of the proof-sheets of J. C. ARMENTROUT'S text-book of Anatomy, Physiology, and Hygiene," and am glad to say that I am sure it will be found of great service to teachers of those very important and much-neglected branches of study in our schools. Substantially the same plan was pursued by Mr. ARMENTROUT in teaching those branches in Iowa City Academy, when it was under the charge of my father, and with great success, so that I have no doubt that it will be found practical, and productive of excellent results in the hands of teachers who take an interest in the subject. Very truly,

E. MCCLAIN,
Resident Professor, Law Department, S. U. I.

IOWA CITY, June 30, 1881.

MR. J. C. ARMENTROUT:—I have examined the general plan of your "Outlines." The matter seems to me well arranged, and sufficiently full for a popular treatment of the subject.

Yours very truly,

J. L. PICKARD,
President State University.

MUSCATINE, IOWA, July 18, 1881.

J. C. ARMENTROUT—*Dear Sir:* I have carefully examined your "Outlines in Anatomy, Physiology, and Hygiene," and must say, that, for simplicity, thoroughness, and practicability, they exceed anything in the text-book line for common schools that I have ever seen. Only an experience of many years in the school-room, presenting these subjects to beginners, could have enabled you to bring out all of the important points in these sciences, and yet not render your work voluminous. In this you have succeeded admirably. I predict for your little work a hearty reception by educators everywhere.

Yours truly,

G. O. MORGRIDGE, M.D.

Having examined the text-book on Anatomy, Physiology, and Hygiene, by J. C. ARMENTROUT, I cheerfully commend the same to school officers and patrons of schools in Johnson county, believing it to be the most thorough, condensed text-book published. The "Outlines" have been used very successfully in the Johnson County Normal Institute for the past four years. I feel confident that this work will be of great aid to the teachers of this county, in presenting these important sciences; also in making interesting and pleasant a subject whch has been considered dull and difficult by many of our teachers and pupils.

W. BLAINE,
Superintendent of Schools, Johnson County, Iowa.

Mr. J. C. ARMENTROUT has used his "Outlines in Anatomy, Physiology, and Hygiene" in Iowa City Academy, during the past three years, with extraordinary success. We do not hesitate to pronounce it the most concise and thorough work of the kind published. We believe it will meet a want long felt in the public schools and academies. Mr. ARMENTROUT has charge of the department of Physiology and Microscopic Anatomy, in our Academy, and we are glad to announce that hereafter his text-book will be used in our classes.

AMOS HIATT, A.M.,
H. H. HIATT, A.M., B.D.
Proprietors and Principals of Iowa City Academy.

This certifies that I am familiar with the "Outlines in Anatomy, Physiology, and Hygiene," by J. C. ARMENTROUT (having assisted him in reading proof), and that, in my judgment, the work is accurate and brief, yet comprehensive. In my opinion it will be a great assistance to both teacher and pupil. If, as I am informed, there has been a need of a work possessing these qualities, that need is supplied, and amply supplied, by the little volume which Mr. ARMENTROUT is presenting to the public.

O. T. GILLETT, M.D.,
Medical Department, State University of Iowa.

IOWA CITY, July 21, 1881.

MR. J. C. ARMENTROUT — *Dear Sir:* I have been permitted to examine some of the advance sheets of your work,—"Outlines in Anatomy, Physiology, and Hygiene,"— and am much pleased with the general arrangement and classification of the subjects treated of. As far as examined, it contains all the essentials to be found in our larger text-books, on these subjects, and I am satisfied it will supply a want long felt both by teachers and students.

J. C. SHRADER, M.D.,
Professor of Obstetrics and Diseases of Women, S. U. I.

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